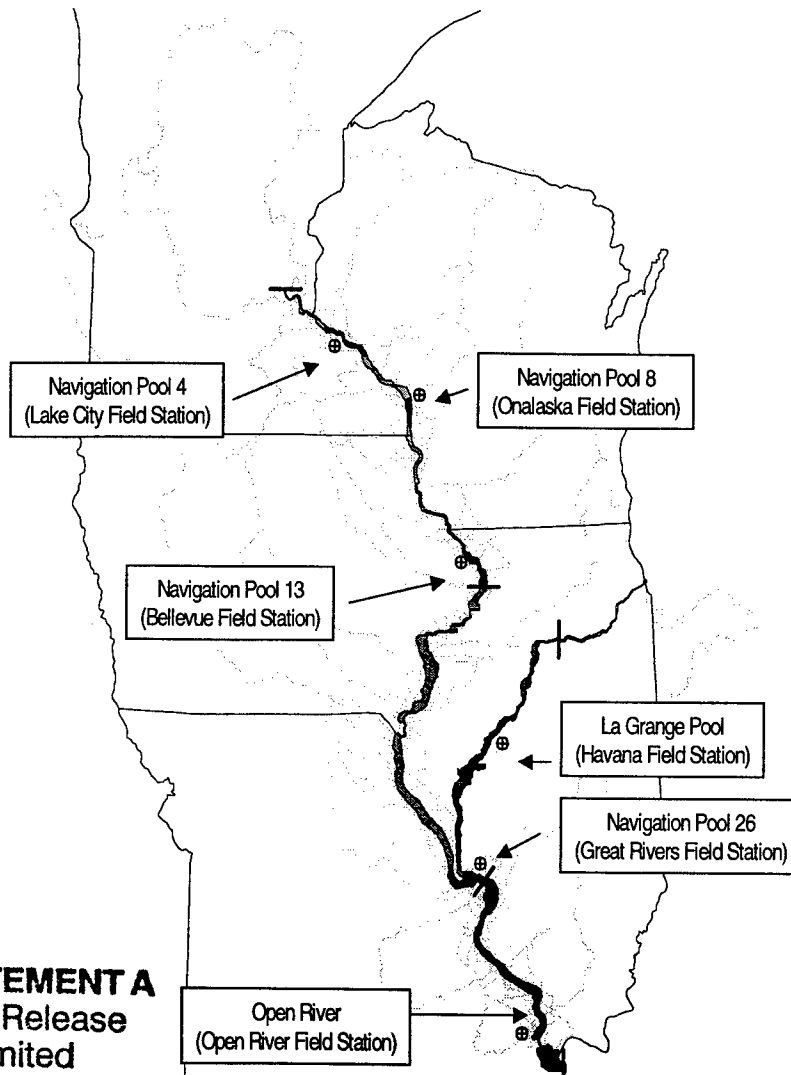




Long Term Resource Monitoring Program

Technical Report 2001-T001

Initial Analyses of Change Detection Capabilities and Data Redundancies in the Long Term Resource Monitoring Program



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Initial Analyses of Change Detection Capabilities and Data Redundancies in the Long Term Resource Monitoring Program

by

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Contents

	<i>Page</i>
Preface	v
Abstract	1
Introduction	1
Monitoring Design	1
Analytical Methods	4
General Analytical Design	4
Change Detection	4
Sampling Frequency	4
Evaluation of Data Redundancies	5
Component Analyses	6
Water Quality	6
Fish	6
Aquatic Vegetation	6
Macroinvertebrates	7
Presentation of Results	7
Results	7
Question 1: What ability do we have to detect change from one year or sampling period to another?	
Water Quality	7
Fish	9
Aquatic Vegetation	12
Macroinvertebrates	13
Sampling Frequency for Macroinvertebrates	14
Question 2: Are there spatial redundancies in the Program?	15
Multiyear Patterns from Trend Analysis Areas	16
Question 3: Are there gear or method redundancies in the Program?	16
Fish	16
Aquatic Vegetation	18
Question 4: Are there target variable redundancies in the Program?	18
Discussion	19
Acknowledgments	21
References	21
Appendix A. Power Analyses for Water Quality	A-1
Appendix B. List of Fish Collected by the Long Term Resource Monitoring Program	B-1

Appendix C. Power Analyses for Fish	C-1
Appendix D. Catch by Gear Type for Fish of All Sizes	D-1
Appendix E. Catch by Gear Type for Fish Less Than 120 mm	E-1

Tables

<i>Number</i>	<i>Page</i>
1. Types of sampling conducted historically within different aquatic area categories and trend analysis areas for each component of the Long Term Resource Monitoring Program	3
2. Means and ranges of power ($\alpha = 0.2$) for detecting a 20% change in seasonal means of 10 water-quality variables at three levels of effort	8
3. Power (at $\alpha = 0.05$) to detect annual change in mean catch-per-unit-effort (CPUE) for 14 fish species of special interest to partners in the Long Term Resource Monitoring Program (LTRMP)	10
4. Ranges of power ($\alpha = 0.05$) for detecting a 20% annual change in the frequency of occurrence of aquatic vegetation (any species) along transects at halved, present, and doubled levels of effort in trend analysis areas of the Long Term Resource Monitoring Program	13
5. Power ($\alpha = 0.20$) to detect a 20% change in the presence of mayflies and fingernail clams from 1992 through 1999 at halved, present, and doubled levels of effort in trend analysis areas (<i>bold face</i>) and aquatic area categories	14
6. Percent frequency of occurrence for aquatic vegetation observed in Lawrence Lake (Navigation Pool 8) in 1998, using transect and stratified random sampling methods	20
7. Correlation matrix of the water-quality variables measured at stratified random sites of the Long Term Resource Monitoring Program	20

Figures

1. Long Term Resource Monitoring Program Trend Analysis Areas (<i>dark gray</i>) and their associated field stations (<i>symbol</i>)	2
2. Autocorrelations of dissolved oxygen at the 42 fixed sites for lags ranging from 1 week (statistically simulated) to 7 weeks	9
3. Power to detect a 20% change in the annual percentage of a specified habitat type	9
4. Power (at $\alpha = 0.05$) to detect annual change in mean catch-per-unit-effort for fish by gears	11
5. Power ($\alpha = 0.05$) to detect annual change in mean catch-per-unit-effort (CPUE) for individual fish species	12
6. Power curves ($\alpha = 0.20$), at several sample sizes, for detecting a 50% annual change in the frequency of occurrence of an aquatic plant species	14
7. Mean densities of mayflies in the Navigation Pool 8 trend analysis area based on (A) all 7 sampling years, and (B) 3-year sampling intervals	15
8. Mean densities of fingernail clams in the Navigation Pool 8 trend analysis area 1992–1999	15
9. Similarities, as expressed by cluster analysis, among the trend analysis areas across components and aquatic area categories	16
10. Turbidity data from the six trend analysis areas of the Long Term Resource Monitoring Program	18
11. Aquatic vegetation response over 8 years at transects in five trend analysis areas	19

Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Upper Midwest Environmental Sciences Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report was prepared under Strategy 2.3.1, *Multi-component Syntheses* under Goal 2, *Monitor Resource Change* of the Operating Plan (U.S. Fish and Wildlife Service 1993). This report was prepared under Section 6.1, Analysis of Monitoring Designs, in the Scope of Work for Implementation of the Long Term Resource Monitoring Program Element of the Upper Mississippi River System-Environmental Management Program for Fiscal Year 2000. This report was developed with funding provided by the LTRMP. The purpose of the report is a first step in the evaluation of the adequacy and effectiveness of the LTRMP sampling designs.

Initial Analyses of Change Detection Capabilities and Data Redundancies in the Long Term Resource Monitoring Program

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Abstract: Evaluations of Long Term Resource Monitoring Program sampling designs for water quality, fish, aquatic vegetation, and macroinvertebrates were initiated in 1999 by analyzing data collected since 1992 in six trend analysis areas. Initial emphasis was placed on evaluating statistical power to detect change from one year or sampling interval to the next, and on determining what spatial, methodological, or target variable redundancies existed in the data sets. Power to detect change was evaluated at halved, present, and doubled levels of effort. Power to detect change for different variables varied widely and was greatly influenced by sample size and for species by their frequency of occurrence. Power for detecting annual and seasonal changes in most water-quality variables seems adequate. A doubling of effort would provide little increase in power, and some reduction or redistribution of effort may be possible. For fish, we could detect a 20% change (at $\alpha = 0.05$ and power of 0.7) in annual mean catch-per-unit-effort for 41 species in at least one trend analysis area. Doubling effort would not appreciably enhance power for rare species. Power for detecting change in aquatic vegetation seemed adequate. However, power for detecting change in macroinvertebrates was low, especially in Navigation Pool 26, the Open River, and La Grange Pool. Results of these analyses should provide useful information for evaluating the effects of potential changes to sampling designs.

Key words: fish, Long Term Resource Monitoring Program, macroinvertebrates, Mississippi River, monitoring, power analysis, sampling design, statistical analysis, vegetation, water quality

Introduction

Sampling of water quality, fish, aquatic vegetation, and macroinvertebrates through the Long Term Resource Monitoring Program (LTRMP, Program) has been under way at six field stations since 1992. Before 1999, Program analyses focused on subsets of data relevant to specific questions or hypotheses. In 1999, LTRMP staff began more comprehensive analyses to assess the scientific adequacy of the Program's databases. The objective of initial analyses performed in 1999 was to evaluate levels of statistical power and potential redundancies associated with the data compiled during the Program's early years. This report highlights major findings of these initial analyses.

Such analyses are desirable at regular intervals in any major monitoring effort to improve Program efficiency. The analyses done in 1999 were especially timely for the LTRMP for two reasons:

(1) Short-term budget cuts were expected to reduce sampling intensity, and (2) the analyses were required to assess the potential loss of information associated with different cost-cutting strategies. At the same time, Congressional reauthorization of the LTRMP for an extended period was anticipated, and these analyses would be useful to guide future Program development.

This report examines the statistical adequacy exhibited by the LTRMP component databases. The analyses initiated in 1999 represent a first step toward critical analyses of the efficiency and scientific defensibility of the LTRMP.

Monitoring Design

State and federal natural resource managers and scientists collaboratively developed the initial LTRMP monitoring design (Upper Mississippi River Conservation Committee 1980; Jackson et

al. 1981; U.S. Fish and Wildlife Service 1987), recommending a monitoring approach that was spatially and ecologically comprehensive and integrated (Upper Mississippi River Conservation Committee 1980). Integration included assessing physical, chemical, and biological elements and their responses to natural and human-induced impacts, all within similar locations (Jackson et al. 1981). From 1992 to 1999, the major components monitored by the LTRMP were water quality, fish, aquatic vegetation, and macroinvertebrates. Monitoring is presently conducted on five navigation pools (four on the Upper Mississippi River and one on the Illinois River) and an open-river area within the unimpounded reach of the Upper Mississippi River near Jackson, Missouri (Figure 1). These six areas are referred to in this report as the LTRMP Trend Analysis Areas.

Initially, most sampling was done at fixed sites. Component designs now include fixed and random sampling sites, stratified by aquatic area categories (Wilcox 1993). Aquatic area categories are similar to traditional fish habitat types (Rasmussen 1979). The term "habitat" was considered an inappropriate label for these categories, which were intended to function primarily as mapping units, defined more by plan form features than by physical and chemical features or by species distribution data. Distribution of sampling sites across aquatic area categories differs by component and trend analysis area (Table 1). The absence of nonchannel habitats, for instance, in the Open River trend analysis area, restricted the location of sampling sites to channel categories.

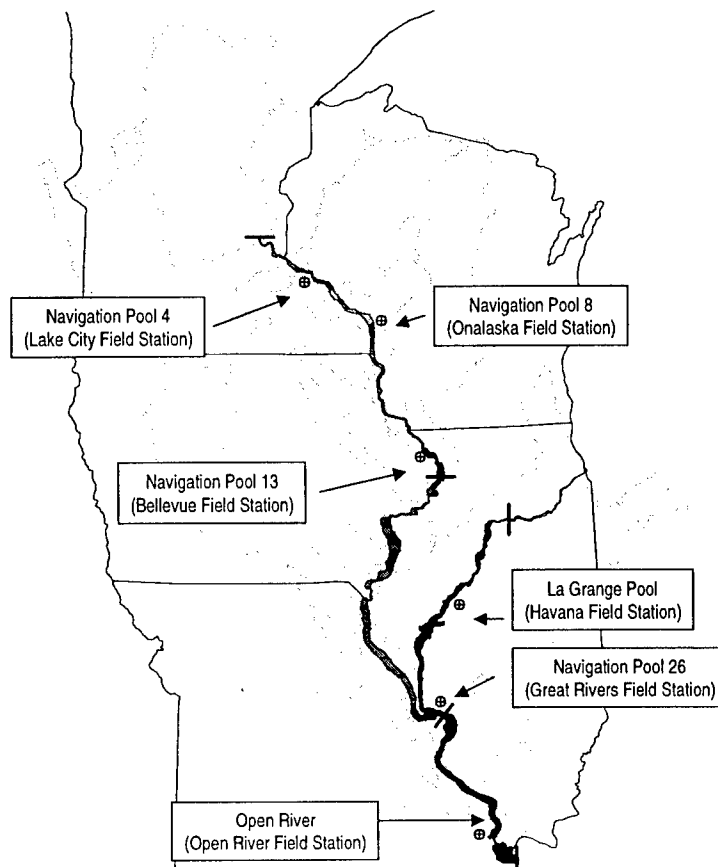


Figure 1. Long Term Resource Monitoring Program Trend Analysis Areas (dark gray) and their associated field stations (symbol). Black bars separate floodplain reaches that have different land cover features and human-use histories (U.S. Geological Survey 1999)

River ecosystem conditions often depend on the hydrologic regime and can vary considerably within and among years in response to hydrologic variables. Thus, it is important that hydrologically controlled changes be distinguished from long-term changes resulting from human alterations of the river. Each LTRMP component was sampled at a time and frequency thought to best characterize its dynamics. Annual observations were considered a basic temporal element of the LTRMP. Additional criteria used to guide sample timing and frequency included minimizing random variation and maximizing sampling efficiency.

Sampling gears and methods were designed to effectively and accurately estimate target variables

Table 1. Types of sampling conducted historically within different aquatic area categories and trend analysis areas for each component of the Long Term Resource Monitoring Program. Aquatic area categories (Wilcox 1993) are hierarchical and represent different levels of spatial resolution. In the table heading, any single category is contained within all other categories that are listed to its left and higher within the heading. For example, the category of "Main channel border unstructured" is contained within "Main channel border," which is contained within "Main channel."

Component	Trend analysis area	Aquatic area categories									
		Channel categories					Backwater categories				
		Main channel border	Main channel border unstructured	Main channel border wing dam	Main channel border tallwater	Side channel border	Tributary channel	Contiguous lake	Contiguous lake shoreline	Contiguous lake offshore	Contiguous isolated delta lake ^c
Water quality ^a	Pool 4	SRS,BF				SRS,BF	BF	SRS,BF		BF	SRS,BF
	Pool 8	SRS,BF				SRS	BF	SRS,BF		SRS,BF	SRS
	Pool 13	SRS,BF				SRS,BF		SRS,BF		SRS,BF	
	Pool 26	SRS,BF				SRS	BF	SRS,BF		SRS,BF	BF
	Open River	SRS,BF				SRS,BF	BF				
	La Grange Pool	SRS,BF				SRS,BF	BF	SRS,BF			BF
Fish ^b	Pool 4		D,HL,HS,S,M	D,M,SHL,HS	F,HS,HL,M,T				D,F,M	D, X,Y,TA	
	Pool 8		D,HL,HS,S,M,N	D,M,SHL,HS	S,N,HS,HL,M,T	D,HL,HS,S,M,N			D,F,M,S	X,Y,HL,HS	
	Pool 13		D,HL,HS,S,M,N	D,HL,HS,S,M,N	N,HS,HL,M,T	D,HL,HS, S, M			D,F,M,S,N	X,Y	HL,HS,X,Y
	Pool 26		D,F,HL,HS,S,M	D,S,HL,HS	N,T	D, F, M, HL, HS			D, F, M	X,Y,HL,HS	HL,HS,X,Y
	Open River		D,F,HL,HS,S,M	D,M,HL,HS, F		D,F,HL,HS,G,M	D,F,HL,HS,G,M				HL,HS,X,Y,TA
	La Grange Pool		D,HL,HS,S,M,		D,S,N,HS,HL,M,T	D,HL,HS,S,M,N			D,F,M,S	X,Y, HL, HS	
Aquatic vegetation ^c	Pool 4	SRS						SRS,TRN			SRS,TRN
	Pool 8	SRS						SRS,TRN			SRS,TRN
	Pool 13	SRS						SRS,TRN	SRS		SRS,TRN
	Pool 26	SRS						SRS,TRN	SRS,TRN		SRS,TRN
	Open River										
	La Grange Pool	SRS						SRS,TRN			SRS,TRN
Macroinvertebrates ^d	Pool 4	SRS									
	Pool 8	SRS				SRS					SRS
	Pool 13	SRS				SRS				SRS	
	Pool 26	SRS				SRS				SRS	
	Open River	SRS				SRS				SRS	
	La Grange Pool	SRS				SRS					

^aSampling codes for water quality, aquatic vegetation, and macroinvertebrates are SRS = stratified random sampling; BF = biweekly fixed sampling; TRN = transect sampling.

^bSampling codes for fish are D = day electrofishing, F = fyke net, G = gill net, HL = large hoop net, HS = small hoop net, M = mini-fyke net, N = night electrofishing, S = seining, T = trawling, TA = anchored trammel net, X = tandem fyke net, Y = tandem mini-fyke net.

^cLake Pepin, in Pool 4, and Swan Lake, in Pool 26, are tributary delta lakes but are grouped with impounded areas for some analyses.

within each trend analysis area and aquatic area category. Consistency of methods within each aquatic area category, across all trend analysis areas, was considered an important aspect of the LTRMP. Descriptions of sampling methods for components were provided by Gutreuter et al. (1995), Soballe et al. (1995), Thiel and Sauer (1999), and Yin et al. (2000). More detailed information about sampling methods is included in the sections that follow when needed to evaluate power and redundancy issues.

Analytical Methods

General Analytical Design

Change Detection

We considered two options for evaluating the statistical ability of the present monitoring program to detect change over time. The first option was trend analysis. A trend analysis determines if a statistically significant trend is apparent in the data over time. Confidence in trend detection is influenced by the duration of monitoring and generally improves with time. The second option was evaluating change from one year to the next. In choosing between these options, we reasoned that it was less important for us to identify trends than it was to determine how well we could document an annual change at existing levels of effort. If we were collecting enough samples to successfully detect annual change, then we assume that we could adequately detect multiyear trends.

We used power analysis to assess how well we can detect change from one period to the next. Power analyses are more relevant to the early warning function of the LTRMP than are trend analyses. Power is defined as $1 - \beta$, where β = Type II error, the chance of accepting (i.e., failing to reject) a false null hypothesis (Peterman 1990).

For evaluating LTRMP data, the typical null hypothesis assumed no change in a variable from one period to the next. Accepting a false null hypothesis would mean that a change did indeed

take place between the periods, but that monitoring data failed to detect it. For example, consider a case in which dissolved oxygen, an important variable influencing the quality of aquatic habitats, declined between Year 1 and Year 2, but our data were insufficient to detect the change. Therefore, we would wrongly accept the null hypothesis. Greater power reduces the probability of missing such a change when it actually happens. However, the ecological and management significance of this “statistical mistake” would depend upon the magnitude of change and upon the true oxygen concentration relative to the needs of various aquatic organisms.

Several factors influence power, including the test procedure (model), significance level (α), sample size, and effect size (Johnson 1999). For any given null hypothesis, test procedure, and significance level, power is inversely related to sample size, but the relation is not always linear. For these analyses, we were mostly concerned with the influence of sample size, a factor that can be easily modified by program managers. Thus, we estimated the power associated with the present level of sampling effort and at half and twice the present effort. Power at one half and twice the present effort was estimated by recalculating the sample variance to reflect a halving or doubling of sample size. Analyses were conducted using SAS statistical software and the procedures Corr, Expand, Insight, Means, GLM, and gPlot.

We conducted additional analyses when it seemed that greater flexibility was required to understand an emerging pattern. For instance, one analysis was conducted to explore how temporal changes in a defined habitat could be assessed with water-quality data.

Sampling Frequency

We also considered sampling frequencies needed to assess important ecological cycles of the target variables. Given sufficient time, the monitoring designs were intended to distinguish short-term from long-term variations and to allow

rapid detection of changes that have important ecological consequences.

Annual sampling has been a key aspect of the LTRMP temporal design; however, biological response variables can lag behind physical variables. In addition, annual variation may be relatively less important for organisms with long-life spans than for those with short-life spans. Long-term trends may be identifiable without annual sampling. A recent proposal for decreasing monitoring costs of the LTRMP suggested that multiyear sampling options be considered. A 3- or 5-year repeated sampling design similar to that used under the National Water Quality Assessment Program was offered as a potential option for some LTRMP variables. We explored potential advantages and disadvantages of multiyear sampling for macroinvertebrates, organisms with short-life spans.

Evaluation of Data Redundancies

The three potential sources of data redundancy evaluated in 1999 were space, sampling gears, and target variables. Evaluations of spatial redundancies addressed several scales. The LTRMP monitoring design emphasizes patterns at three scales relevant to the ecology of floodplain rivers, floodplain reach, navigation pool, and habitat (Lubinski 1993). The initial siting of the LTRMP Trend Analysis Areas was based, in part, on differences in ecosystem structure and human use among several reaches of the Upper Mississippi River System. By using pool boundaries to delimit five of the six trend analysis areas, we acquired the ability to study and quantify within-pool structural patterns and longitudinal gradients associated with impoundment. The aquatic area classification scheme was established to test the perceived ecological distinctions among aquatic habitat types. Biweekly sampling of water quality at selected tributary mouths attempts to understand patterns at a fourth spatial scale, the stream network.

Three trend analysis areas (Navigation Pools 4, 8, and 13) are located in the Upper Impounded Reach of the Upper Mississippi River. One trend analysis area is located in each of three other

floodplain reaches (Figure 1). Each monitoring component requires samples from multiple aquatic area categories (Table 1). The proportions of samples within each aquatic area category differ by component, and the proportions of aquatic area categories differ within each trend analysis area.

During discussions on downsizing LTRMP, proposals included various options for eliminating or reducing sampling in one or more trend analysis area or aquatic area category. The basic premise was that if two trend analysis areas or aquatic area categories yielded similar information, one could be considered for elimination from the design.

Similarities between trend analysis areas were evaluated using cluster analysis. Callahan (1998) noted that statistical procedures designed to test hypotheses and determine *p*-values are not appropriate for identifying similarities among trend analysis areas because these procedures tend to indicate that groups with high variance and small sample size are similar regardless of other attributes. Cluster analysis is not used to test hypotheses, but rather to sort and group observations. Hierarchical cluster analysis results are summarized in dendrograms. Each step of the hierarchical clustering algorithm is represented as a node on the dendrogram. The height of each node represents the similarity of the clusters being joined, and groups merged toward the bottom of a dendrogram are more similar than groups merged toward the top (Callahan 1998).

The cluster analyses and figures included in this report were selected because of their value in addressing potential informational losses associated with eliminating a trend analysis area or with redistributing effort within or among the trend analysis areas. Cluster analyses were performed using S-Plus statistical software (Venables and Ripley 1999). Distance measures for the clusters were Euclidian distances for the water-quality component, and correlation coefficients for other components.

The evaluation of gear or method redundancies in the LTRMP applies specifically to the fish and aquatic vegetation components. Fish were sampled

with a variety of gears intended to efficiently collect fish in the varying conditions found within each aquatic area category. Aquatic vegetation was sampled using two methods—transect sampling and stratified random sampling—the latter began in 1998. The question of target variable redundancies was directed primarily at the water-quality component.

Component Analyses

Water Quality

Between 1993 and 1996, water-quality monitoring was designed to yield information at several spatial and temporal scales (Table 1). Quarterly stratified random sampling addressed patterns at seasonal and annual temporal scales and at both trend analysis area and aquatic area category spatial scales. Biweekly, fixed-site sampling was designed to track fluctuations at temporal scales of a month or longer (e.g., as might be associated with substantial changes in river discharge). Fixed sites on selected tributaries, dams, or channel cross-sections were intended to monitor conditions associated with upstream drainages or reaches.

Water-quality variables that were measured *in situ* included dissolved oxygen, temperature, conductivity, turbidity, and Secchi disk transparency. Quantification of nitrogen, phosphorus, and suspended solids required laboratory analysis of water samples. Water samples for laboratory analysis were collected at half of the quarterly stratified random sites and at all of the biweekly fixed sites.

Two additional analyses were conducted using water-quality variables. A binomial approach was used to investigate our ability to detect annual changes in availability of overwintering habitat for sunfish. This approach is applicable to any study that involves estimating the frequency of occurrence of sites meeting certain criteria.

The second analysis was an autocorrelation of dissolved oxygen measurements to determine if LTRMP is oversampling with a biweekly schedule at fixed sites. The analysis used oxygen data from

42 sampling sites in the main channel, side channels, and tributaries. The analysis indicated how well an oxygen measurement at a given point in time could be predicted from an earlier measurement at the same location (autocorrelation). If one value can be predicted from another, then the two measurements are redundant. Oxygen is less variable than other constituents, thus if the frequency of oxygen sampling was not excessive, then we reasoned that other, more time-variant constituents, were not oversampled either.

Fish

Multiple gears were used to sample fish from 1993 through 1999. The design was intended to evaluate the fish community within each LTRMP Trend Analysis Area, by relevant aquatic area category, as opposed to focusing on one or more individual species. Fish gears (Table 1) were selected based on the experience of fishery biologists to maximize sampling efficiency within different aquatic area categories.

In each year, fish were sampled during three periods: early summer (June 15–August 1); late summer (August 2–September 15); and fall (September 16–October 31). Fish catch-per-unit-effort (CPUE) was transformed with the 4th root method to normalize the data and reduce the influence of zero catches.

Aquatic Vegetation

Sampling along fixed transects for submersed and rooted floating-leaf vegetation was conducted from 1991 to 1998 in contiguous backwaters, isolated backwaters, and impounded areas (Table 1). No transects were established in the Open River trend analysis area because it lacks backwater and impounded habitat. Transect sampling was conducted twice per year, first in spring between May 15 and June 15, and again in summer between July 15 and August 15, in recognition of the changing dominance of plant species during the growing season.

To address additional questions about the occurrence of submersed and rooted floating-leaf

vegetation at the trend analysis area scale, an experimental stratified random design was implemented in 1998. Sites less than 3 m deep in main channel border, side channel border, contiguous backwater, isolated backwater, and impounded aquatic area categories were sampled (Table 1). To evaluate potential problems that might arise as a result of switching from transect to stratified random sampling, we compared species richness, species abundance, and community abundance results obtained from both methods in three backwaters during 1998.

Macroinvertebrates

Macroinvertebrate sampling from 1992 to 1999 was based on a stratified random design in which samples were distributed within aquatic area categories believed to have soft (sand, mud, or sand-mud mixture) substrates. Nearby substitute sites were sampled when primary locations could not be sampled with a Ponar dredge because of aquatic vegetation or hard substrate (rocks, cobble, hard clay). In each trend analysis area, about 125 samples were collected annually. Samples were processed in the field. Data were recorded for five macroinvertebrate taxa, but initial analyses in 1999 were limited to mayflies (Ephemeroptera) and fingernail clams (Sphaeriidae).

Data on macroinvertebrate density were not normally distributed, and frequent zero values were recorded. To reduce the influence of these zero values on the analyses, we performed the initial power analyses on presence/absence of data.

Presentation of Results

To link the discussion of the analyses initiated in 1999 to potential Program restructuring issues, results were grouped according to four discussion questions. This organizational and reporting approach was reviewed and approved by the LTRMP Analysis Team. The questions were as follows:

1. What ability do we have to detect change from one year or sampling period to another?

2. Are there spatial redundancies in the Program?
3. Are there gear or method redundancies in the Program?
4. Are there target variable redundancies in the Program?

The analyses treated the monitoring components as individual elements. Statistical analyses or graphic presentations were often repeated for multiple variables or species, at both trend analysis area and aquatic area category scales, and in the case of fish, for different gear types. Selected results were used to illustrate and summarize discussion points in the sections that follow.

Some reporting conventions were necessary, such as reporting power at halved, present, and doubled levels of effort across all components. Other conventions, such as fixed levels of α (alpha) for the power analyses, were used when feasible. We did not, however, adhere to strict reporting consistencies across all components if doing so would have forced us to present results that did not demonstrate the greatest sensitivity of response. We frequently (but not always) presented power results using $\alpha = 0.2$ because this value is commonly applied in monitoring programs in which the consequences of "sounding a false alarm" are deemed to be less worrisome than the consequences of failing to detect a "population decline" (Gibbs et al. 1998). We presented most power results in terms of detecting either a 20% or 50% change in the mean of a variable from one year or period to the next.

Results

Question 1: What ability do we have to detect change from one year or sampling period to another?

Water Quality

Means and ranges of power estimates for 10 water-quality variables at halved, present, and doubled levels of effort calculated for all season-to-season changes are presented in Table 2. More

detailed results showing power for each water-quality variable by aquatic area category, trend analysis area, and season are presented in Appendix A.

At present levels of effort, power to detect a 20% change (at $\alpha = 0.2$) in seasonal means of variables measured *in situ* ranged from a low of 0.74 for turbidity to a high of 0.97 for conductivity (Table 2). Power (same conditions) to detect change of laboratory-measured variables ranged from 0.53 for soluble-reactive phosphorus to 0.83 for total nitrogen.

Halving the present level of effort would reduce power to detect change of *in situ* variables to a ranged of 0.60 for turbidity and a high of 0.94 for conductivity (Table 2). Halving the present level of effort would reduce power of laboratory-

measured variables to a range of 0.43 for soluble-reactive phosphorus to 0.73 for total nitrogen.

Doubling the present level of effort would increase power to detect change of *in situ* variables to a range of 0.86 for turbidity and a high of 0.99 for conductivity (Table 2). Doubling the present level of effort would increase power of laboratory-measured variables to a range of 0.64 for soluble-reactive phosphorus to 0.91 for total nitrogen.

Autocorrelations of dissolved oxygen at the 42 fixed sites, for lags ranging from 1 week (statistically simulated) to 7 weeks are summarized in box-whisker plots (Figure 2). The coefficient of determination dropped rapidly beyond 2 weeks to below 50%. This rapid decrease suggested that the present biweekly sampling interval for fixed sites is appropriate to the design concept. A longer

Table 2. Means and ranges of power ($\alpha = 0.2$) for detecting a 20% change in seasonal means of 10 water-quality variables at three levels of effort. Power was calculated for all aquatic area categories and trend analysis areas from 1993 through 1996.

Water-quality variables	Halved effort	Present effort	Doubled effort
Measured <i>in situ</i>			
<i>Dissolved oxygen</i>			
Mean power	0.90	0.93	0.96
Range	0.14 - >0.99	0.16 - >0.99	0.19 - >0.99
<i>Temperature</i>			
Mean power	0.87	0.89	0.92
Range	0.13 - >0.99	0.14 - >0.99	0.16 - >0.99
<i>Conductivity</i>			
Mean power	0.94	0.97	0.99
Range	0.15 - >0.99	0.17 - >0.99	0.21 - >0.99
<i>Turbidity</i>			
Mean power	0.60	0.74	0.86
Range	0.15 - >0.99	0.17 - >0.99	0.20 - >0.99
<i>Secchi disk transparency</i>			
Mean power	0.77	0.88	0.94
Range	0.12 - >0.99	0.13 - >0.99	0.15 - >0.99
Measured in laboratory			
<i>Total suspended solids</i>			
Mean power	0.48	0.62	0.76
Range	0.12 - 0.99	0.12 - >0.99	0.13 - >0.99
<i>Total nitrogen</i>			
Mean power	0.73	0.83	0.91
Range	0.14 - >0.99	0.16 - >0.99	0.19 - >0.99
<i>Nitrate/nitrite</i>			
Mean power	0.60	0.69	0.78
Range	0.11 - >0.99	0.11 - >0.99	0.12 - >0.99
<i>Total phosphorus</i>			
Mean power	0.60	0.72	0.83
Range	0.11 - >0.99	0.11 - >0.99	0.13 - >0.99
<i>Soluble reactive phosphorus</i>			
Mean power	0.43	0.53	0.64
Range	0.11 - >0.99	0.11 - >0.99	0.11 - >0.99

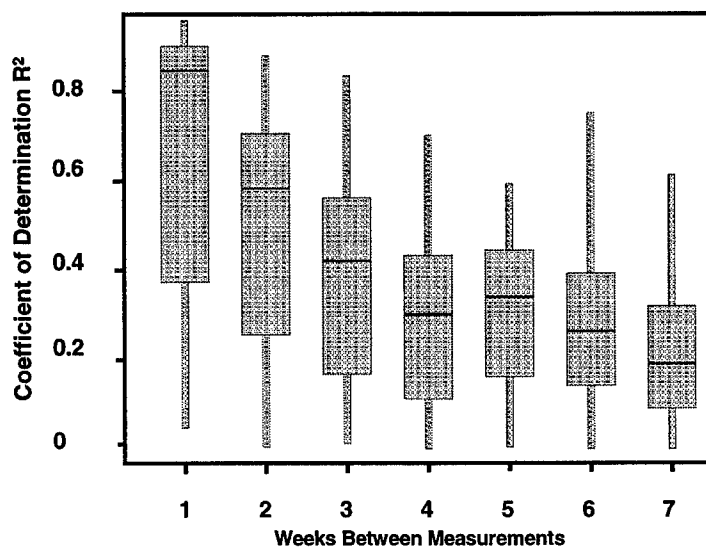


Figure 2. Autocorrelations of dissolved oxygen at the 42 fixed sites, for lags ranging from 1 week (statistically simulated) to 7 weeks. The box-whisker plots show medians, 25th and 75th percentiles, and ranges of coefficient's of determination.

sampling interval could be used to estimate an annual mean, but would increase the chance that large variations among samples could go undetected.

Previous analyses with a binomial approach based on 3 years of water-quality data from Navigation Pool 8 estimated that about 10% of the available backwater habitat was suitable overwintering habitat for sunfish (Soballe and Rogala 1996). With a sample size of 60 (the present effort) and an α of 0.2, power to detect a 20% change in the extent of this habitat among years is about 0.30 (Figure 3). Figure 3 can be used to estimate power for detecting a 20% change in the mean using other α levels and percent frequencies of defined habitat. If suitable habitat increased to 50%, the chance for more of the stratified random sites to fall into that area would increase, and the power to detect a 20% change would increase to around 0.61.

Fish

Power analyses at the present level of effort within all sampled aquatic area categories and trend analysis areas were completed for all species. Table 3 presents gear and aquatic area category combinations that resulted in an ability to detect a 20% or 50% annual change in mean CPUE for 14 priority species identified by LTRMP partners: black crappie, bluegill, channel catfish, common carp, emerald shiner, freshwater drum, gizzard shad, largemouth bass, northern pike, sauger, smallmouth buffalo, walleye, white bass, and white crappie. (Scientific names of fish collected in LTRMP sampling are listed in Appendix B.) More detailed results

showing power by trend analysis area, gear type, and aquatic area category at halved, present, and doubled levels of effort are presented in Appendix C. Power varied widely among species, depending on their relative abundance in the catches by gear type, aquatic area category, and trend analysis area.

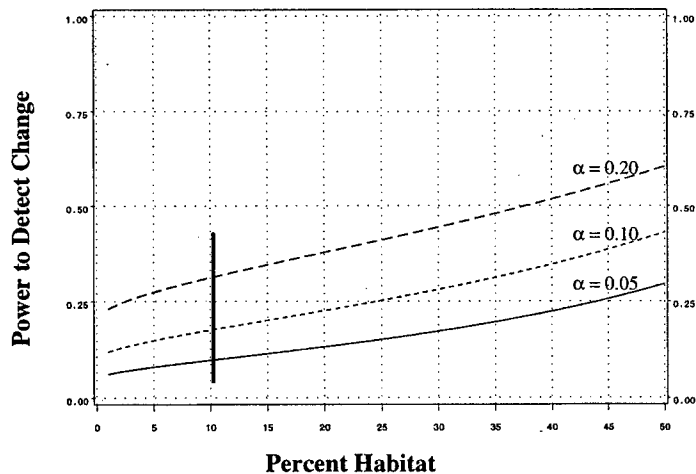


Figure 3. Power to detect a 20% change in the annual percentage of a specified habitat type. For example, the present extent of overwintering habitat for sunfish was estimated to be 10% of the available backwater in Navigation Pool 8. If the water-quality sampling effort for that strata remains the same ($n = 60$), change detection power will be about 0.10, 0.18, and 0.30 at α levels of 0.05, 0.10, and 0.20, respectively (vertical line).

Table 3. Power (at $\alpha = 0.05$) to detect annual change in mean catch-per-unit-effort (CPUE) for 14 fish species of special interest to partners in the Long Term Resource Monitoring Program (LTRMP). Only combinations of gears and aquatic area categories that resulted in a capability to detect a 20% or 50% change in CPUE are listed. Power values with a "<" or ">" sign indicate that power was greater than, or less than, the indicated value for all combinations of gear, aquatic area category, and trend analysis area within that row.

Fish species	Power	Detected percentage of change in mean CPUE	Gear	Aquatic area categories ^a	LTRMP trend analysis area ^b					
					P4	P8	P13	P26	OR	LG
Black crappie	>0.80	20	fyke nets, tandem fyke nets	BWCS, BWCO	X	X	X	X		X
Bluegill	>0.70	20	fyke nets	BWCS	X	X	X	X		X
	>0.85	20	day electrofishing	BWCS	X	X	X	X		X
Channel catfish	>0.60	20	Small hoop nets	MCBU,SCB		X				
	>0.60	20	Small hoop nets, day electrofishing	MCBU,SCB				X	X	X
	0.81	50	Small hoop nets	MCBU			X			
	0.36	50	Small hoop nets	MCBU	X					
Common carp	0.90	20	day electrofishing	SCB	X	X	X	X	X	X
Emerald shiner	>0.75	20	day electrofishing	MCBU	X	X	X			X
	0.65	20	day electrofishing	MCBU				X		
	0.50	20	day electrofishing	MCBU					X	
Freshwater drum	>0.60	20	day electrofishing	BWCS,SCB	X	X	X	X	X	X
Gizzard shad	>0.75	20	day electrofishing	BWCS	X		X	X		X
	0.65	20	day electrofishing	BWCS		X				
	>0.95	20	day electrofishing	MCBU, SCB					X	X
Largemouth bass	>0.75	20	day electrofishing	BWCS	X	X	X			X
	0.22	20	day electrofishing	BWCS				X		
	0.99	20	day electrofishing	IMPS				X		
Northern pike	0.75	50	fyke nets	BWCS		X				
	0.51	50	tandem fyke nets	BWCO	X					
	0.40	50	fyke nets	BWCS			X			
Sauger	0.80	50	day electrofishing	SCB	X	X				X
	<0.40	50	day electrofishing	SCB			X	X	X	
	>0.90	20	night electrofishing ^c	MCBU, SCB		X				
	>0.60	20	night electrofishing ^c	MCBU, SCB			X			
Smallmouth buffalo	0.60	20	large hoop nets	MCBU	X			X		X
	0.60	50	large hoop nets	MCBU		X				
	0.80	50	tandem fyke nets	SCB			X			
	0.70	50	tandem fyke nets	SCB					X	
Walleye	0.68	50	day electrofishing	SCB	X					
	0.34	50	day electrofishing	MCBU		X				
	0.28	50	day electrofishing	MCBU			X			
	>0.90	20	night electrofishing ^c	MCBU,SCB		X				
White bass	>0.60	20	day electrofishing	MCBU	X	X	X	X	X	X
White crappie	>0.70	20	fyke nets	BWCS			X			X
	0.19	50	fyke nets	BWCS	X					
	0.52	50	fyke nets	BWCS		X				
	0.74	50	fyke nets	BWCS				X		

^aBWCO = Backwater contiguous lake offshore, BWCS = Backwater contiguous lake shoreline, IMPS = Backwater contiguous impounded shoreline, MCBU = Main channel border unstructured, SCB = Side channel border.

^bP4 = Navigation Pool 4, P8 = Navigation Pool 8, P13 = Navigation Pool 13, P26 = Navigation Pool 26, OR = Open River; LG = La Grange Pool.

^cNight electrofishing is presently considered an optional (nonmandatory) method in the LTRMP fish monitoring design.

annual catch and variance by species and gear type for each trend analysis area are presented in Appendix D (for fish of all sizes) and Appendix E (for fish less than 120 mm in total length).

When the LTRMP fish sampling design was developed, a multiple gear-aquatic area category approach, intended to evaluate the fish community within each trend analysis area, was selected rather than a target species approach. Thus, although LTRMP partners expressed special interest in the 14 species listed above, we also evaluated information on all species collected within a trend analysis area. During the years under investigation, the fish monitoring design collected 132 of the 139 species reported from the sampled reaches (Fremling et al. 1989).

Power varied considerably among the species and gears (Table 3, Appendix C). For example, Figure 4 demonstrates the range of power observed at present levels of effort for the 77 species collected in Navigation Pool 13 in the aquatic area category of backwater contiguous shoreline with

four different sampling collection methods. Figure 5 shows how power for these species generally increases as mean CPUE increases. Across all species, gears, and aquatic area categories, electrofishing generally produced the greatest power (Table 3, Appendix C). However, for some species and aquatic area categories, fyke nets or hoop nets produced greater power than electrofishing (Table 3, Appendix C).

To evaluate power within a trend analysis area at different levels of effort, we tentatively established a level of 0.70 (to detect a 20% change in mean CPUE of a species from year to year at $\alpha = 0.05$) as a guideline of power adequacy. Results indicated that at present effort levels, this criterion was met for 41 species within at least one trend analysis area. However, our power to detect change in uncommon species (including threatened and endangered species) was limited. For example, the power to detect a 20% change for paddlefish with large hoop nets in the Open River trend analysis area was only 0.20.

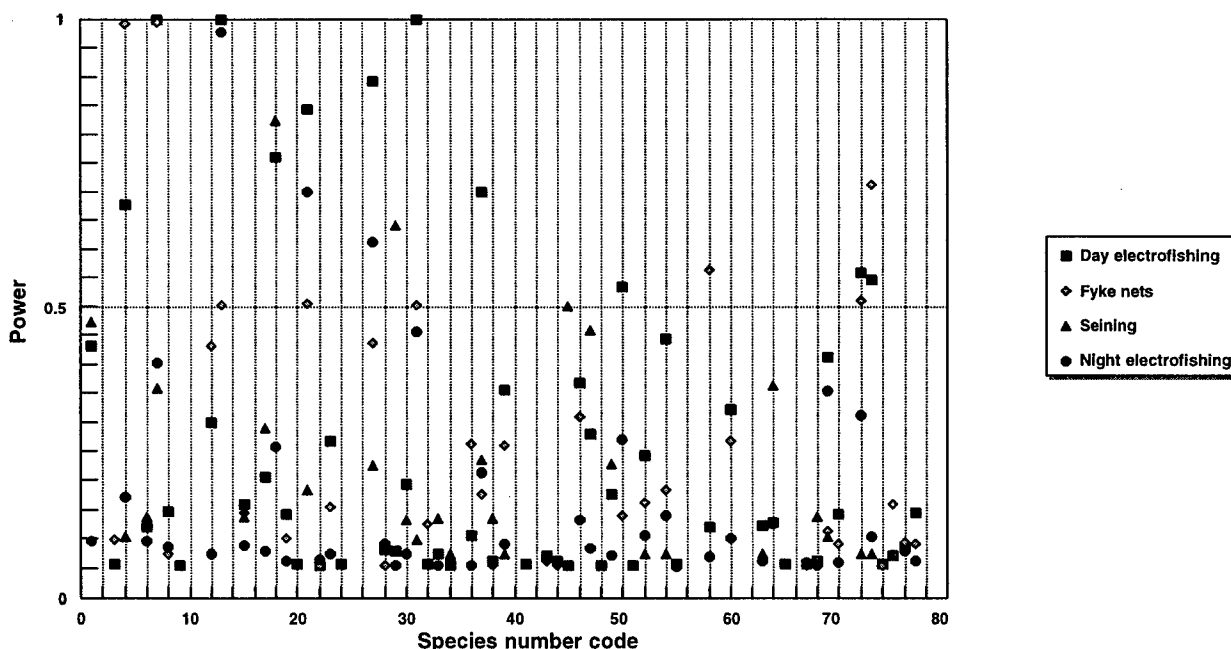


Figure 4. Power (at $\alpha = 0.05$) to detect annual change in mean catch-per-unit-effort for fish by gear. In this example, results are presented for the 77 species collected in backwater contiguous lake shoreline aquatic areas in Navigation Pool 13. Gear symbols in each vertical line are for a single species. Wide variations in power were observed across gears for individual species and across all species.

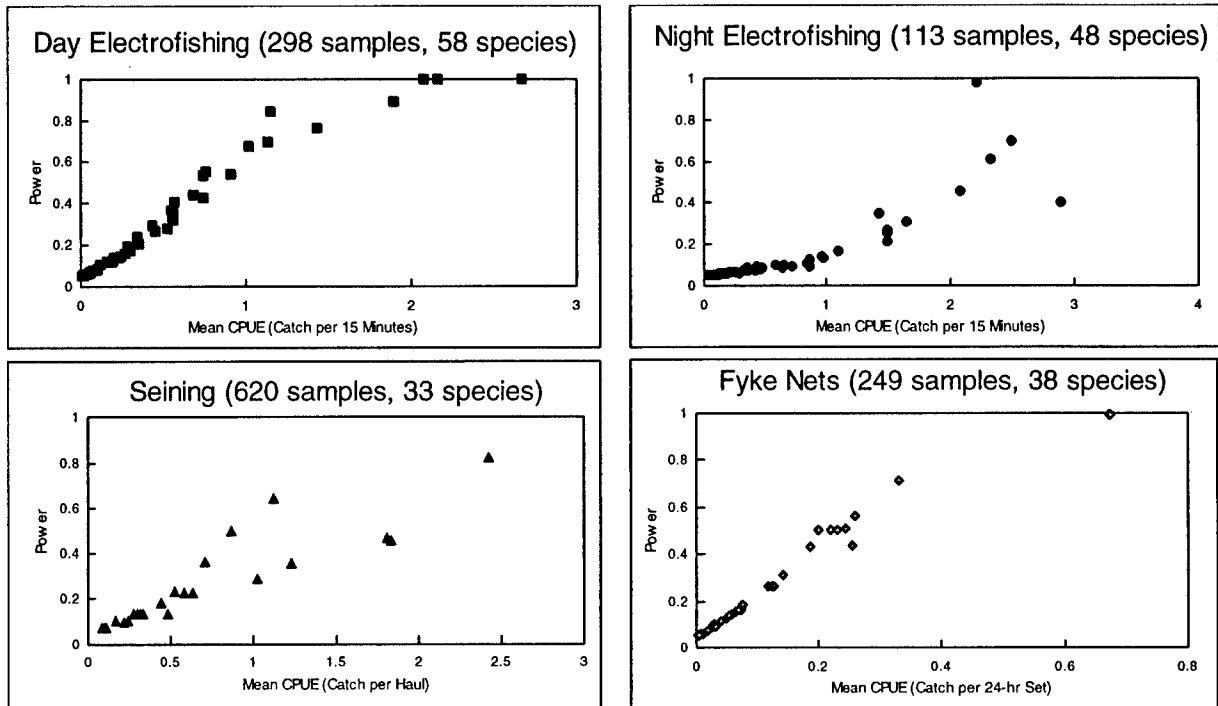


Figure 5. Power ($\alpha = 0.05$) to detect annual change in mean catch-per-unit-effort (CPUE) for individual fish species. The CPUE required to reach a selected power differs by gear and sample size. This example shows results for four gears fished in backwater contiguous lake shoreline aquatic areas of Navigation Pool 13.

Halving our fish sampling efforts reduced the number of species for which we could adequately detect annual change to 25. Doubling our sampling effort increased the number of species to 54, although it would not substantially improve our ability to assess changes in the relative abundances of uncommon species.

Aquatic Vegetation

Observed power ranges for detecting change in the frequency of submersed and rooted floating-leaf vegetation along fixed transects are presented in Table 4. Sample sizes ranged from 18 to 441. At present levels of effort, power to detect a 20% increase or decrease in frequency exceeded 0.50 for most species.

Power was related to sample size and to the frequency of occurrence of each species. Power curves were, therefore, developed to calculate potential power levels for ranges of these factors. Figure 6 presents power curves, at an α of 0.20,

associated with detecting a 50% change in the frequency of a plant species at different starting frequency levels and sample sizes.

The curves presented in Figure 6 are also useful for anticipating power associated with varying sample sizes of future stratified random samples. Stratified random sample sizes across aquatic area categories in 1998 ranged from 30 to 210. Based on Figure 6, at a sample size of 30, power would be 0.7 or greater for detecting a 50% change for species with a frequency of occurrence greater than 0.45. At a sample size of 200, the same power would be achieved for species with frequencies of occurrence greater than about 0.07. Because 1998 was the first year of stratified random sampling for aquatic vegetation, no direct observations of change over time were possible.

Macroinvertebrates

Power to detect a 20% annual change (at $\alpha = 0.20$) in the presence of mayflies and fingernail

Power to detect a 20% annual change (at $\alpha = 0.20$) in the presence of mayflies and fingernail clams, within aquatic area categories and within trend analysis areas (all aquatic area categories combined) are presented in Table 5. Power was consistently greater in Navigation Pools 4, 8, and 13 because of the greater frequencies of occurrence of macroinvertebrates in the nonchannel aquatic area categories of these trend analysis areas.

The lack of nonchannel aquatic area categories in the Open River and their limited presence in Navigation Pool 26 and La Grange Pool required that greater proportions of samples be allocated to main channel border and side channel areas of these three trend analysis areas. Channel areas are characterized by relatively high current velocities, especially at high river discharges, and by coarse sand substrates. These conditions are less suitable for the targeted soft-substrate macroinvertebrates. Low frequencies of occurrence of

Table 4. Ranges of power ($\alpha = 0.05$) for detecting a 20% annual change in the frequency of occurrence of aquatic vegetation (any species) along transects at halved, present, and doubled levels of effort in the Long Term Resource Monitoring Program Trend Analysis areas. Vegetation sampling was not conducted in Open River.

Trend analysis area	Transect	Halved effort	Present effort	Doubled effort
Pool 4	Big Lake	0.61 - 0.99	0.92 - 0.99	>0.99
	Rice Lake	0.37 - 0.99	0.57 - 0.99	0.88 - 0.99
	Catherine Pass	0.38 - 0.99	0.58 - 0.99	0.90 - 0.99
	Dead Slough	0.54 - 0.99	0.86 - 0.99	>0.99
	Goose Lake	0.26 - 0.99	0.31 - 0.99	0.45 - 0.99
	Mud Lake	0.33 - 0.99	0.49 - 0.99	0.78 - 0.99
	Lower Peterson	0.53 - 0.99	0.84 - 0.99	>0.99
	Upper Peterson	0.44 - 0.99	0.70 - 0.99	0.97 - >0.99
	Robinson Lake	0.75 - 0.99	≥0.99	>0.99
Pool 8	Blue Lake	0.54 - 0.99	0.86 - 0.99	>0.99
	Goose Island	0.49 - 0.99	0.79 - 0.99	≥0.99
	Horseshoe HREP ^a	0.43 - 0.99	0.63 - 0.99	0.94 - 0.99
	Lawrence Lake	≥0.99	≥0.99	≥0.99
	Pool 8 Islands	0.46 - 0.99	0.74 - 0.99	0.98 - 0.99
	Shady Maple	0.46 - 0.99	0.75 - 0.99	≥0.99
	Stoddard	0.31 - 0.99	0.45 - 0.99	0.72 - 0.99
	Target Lake	0.89 - 0.99	≥0.99	≥0.99
Pool 13	Brown's Lake	≥0.99	>0.99	>0.99
	Johnson Creek Levee	0.48 - 0.99	0.78 - 0.99	≥0.99
	Lower Johnson Creek	0.36 - 0.99	0.54 - 0.99	0.86 - 0.99
	Pomme de Terre	0.41 - 0.99	0.64 - 0.99	0.94 - 0.99
	Potter's Marsh	0.54 - 0.99	0.85 - 0.99	>0.99
	Savanna Bay	0.57 - 0.99	0.89 - 0.99	>0.99
	Spring Lake	0.67 - 0.99	0.96 - 0.99	>0.99
Pool 26	Calhoun Point	0.59 - 0.99	0.90 - 0.99	>0.99
	Fuller Lake	0.65 - 0.99	0.95 - 0.99	>0.99
	Stump Lake	0.64 - 0.99	0.94 - 0.99	>0.99
	Swan Lake	0.89 - 0.99	>0.99	>0.99
La Grange Pool	Bulrush Pond	0.24 - 0.98	0.28 - 0.99	0.37 - 0.99
	Grape Island	0.24 - 0.52	0.28 - 0.83	0.37 - 0.99
	Point Lake	0.26 - 0.93	0.31 - 0.99	0.45 - 0.99
	Spring Lake	0.41 - 0.95	0.65 - 0.99	0.95 - 0.99

^aHREP = Habitat Rehabilitation and Enhancement Project

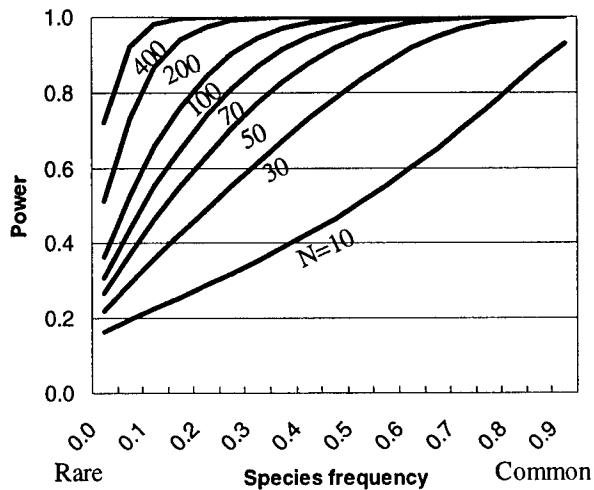


Figure 6. Power curves ($\alpha = 0.20$), at several sample sizes, for detecting a 50% annual change in the frequency of occurrence of an aquatic plant species.

macroinvertebrates in these areas reduced our power to detect change. Moreover, estimated levels of power at double the present effort were still low.

Sampling Frequency for Macroinvertebrates

Figure 7 presents annual monitoring results for mayflies in Navigation Pool 8. Figure 7A includes results from all years and suggests a cycle in mayfly densities. Figure 7B shows the different data sets that would have resulted from sampling at 3-year intervals with different starting years. The 3-year sampling result suggest trends, but the mean abundance estimated over all years would be similar for each data set.

Table 5. Power ($\alpha = 0.20$) to detect a 20% change in the presence of mayflies and fingernail clams from 1992 through 1999 at halved, present, and doubled levels of effort in trend analysis areas (*bold face*) and aquatic area categories.

Trend analysis area	Aquatic area category ^a	Mayflies			Fingernail clams		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	All	0.39	0.54	0.75	0.31	0.41	0.57
	BWC	0.33	0.44	0.62	0.25	0.30	0.38
	IMP	0.35	0.47	0.66	0.45	0.63	0.85
	MCB	0.20	0.21	0.21	0.20	0.20	0.21
	SC	0.20	0.21	0.22	0.20	0.20	0.21
Pool 8	All	0.38	0.52	0.73	0.27	0.33	0.44
	BWC	0.27	0.34	0.45	0.22	0.25	0.29
	IMP	0.32	0.42	0.59	0.24	0.28	0.35
	MCB	0.20	0.20	0.21	0.20	0.20	0.21
	SC	0.22	0.25	0.29	0.21	0.22	0.23
Pool 13	All	0.50	0.69	0.89	0.54	0.75	0.93
	BWC	0.37	0.51	0.71	0.36	0.49	0.68
	IMP	0.36	0.49	0.68	0.48	0.67	0.88
	MCB	0.21	0.22	0.23	0.21	0.22	0.23
	SC	0.22	0.25	0.29	0.22	0.24	0.28
Pool 26	All	0.23	0.26	0.33	0.21	0.22	0.24
	BWC	0.25	0.29	0.37	0.21	0.22	0.23
	IMP	0.24	0.27	0.34	0.21	0.22	0.24
	MCB	0.20	0.21	0.21	0.20	0.20	0.20
	SC	0.20	0.21	0.22	0.20	0.20	0.20
Open River	All	0.24	0.27	0.34	0.20	0.21	0.22
	MCB	0.21	0.23	0.26	0.20	0.20	0.20
	SC	0.23	0.26	0.38	0.20	0.20	0.20
La Grange Pool	All	0.25	0.29	0.37	0.26	0.32	0.43
	BWC	0.22	0.24	0.28	0.22	0.24	0.28
	MCB	0.21	0.26	0.24	0.23	0.25	0.21
	SC	0.25	0.30	0.38	0.25	0.29	0.38

^aBWC = Backwater contiguous lake; IMP = Backwater contiguous impounded; MCB = Main channel border; SC = side channel.

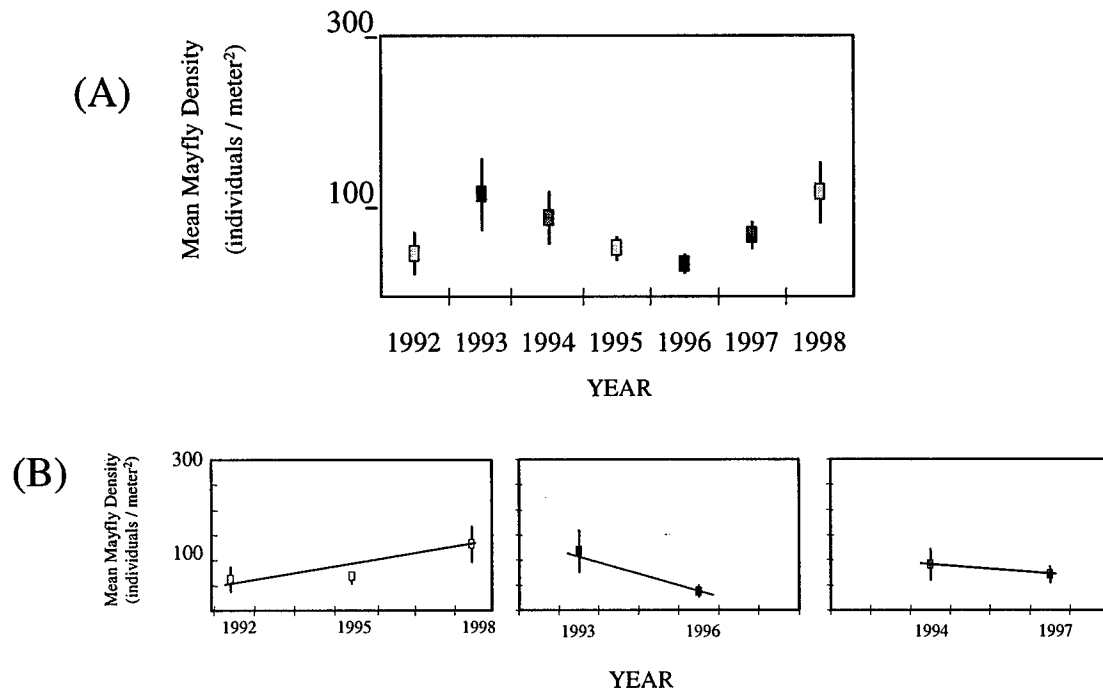


Figure 7. Mean densities of mayflies in the Navigation Pool 8 trend analysis area based on (A) all 7 sampling years, and (B) 3-year sampling intervals. Vertical lines indicate ± 1 standard error.

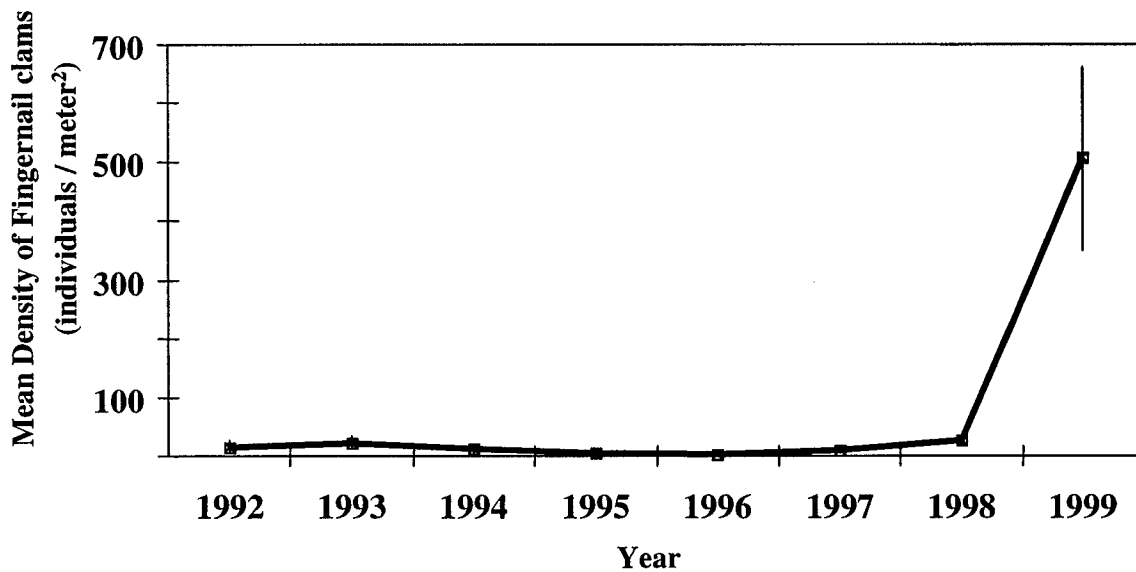


Figure 8. Mean densities of fingernail clams in the Navigation Pool 8 trend analysis area 1992-1999. Vertical lines indicate ± 1 standard error.

fingernail clam densities in Navigation Pool 8, densities increased rapidly in 1999 (Figure 8), coinciding with a substantial increase in the use of the area by migratory waterfowl in fall 1999. Rapid changes, such as this, are most effectively documented with a sampling interval of 1 year or less.

Question 2: Are there spatial redundancies in the Program?

Figure 9 provides examples of cluster analyses based upon the four monitoring components. These

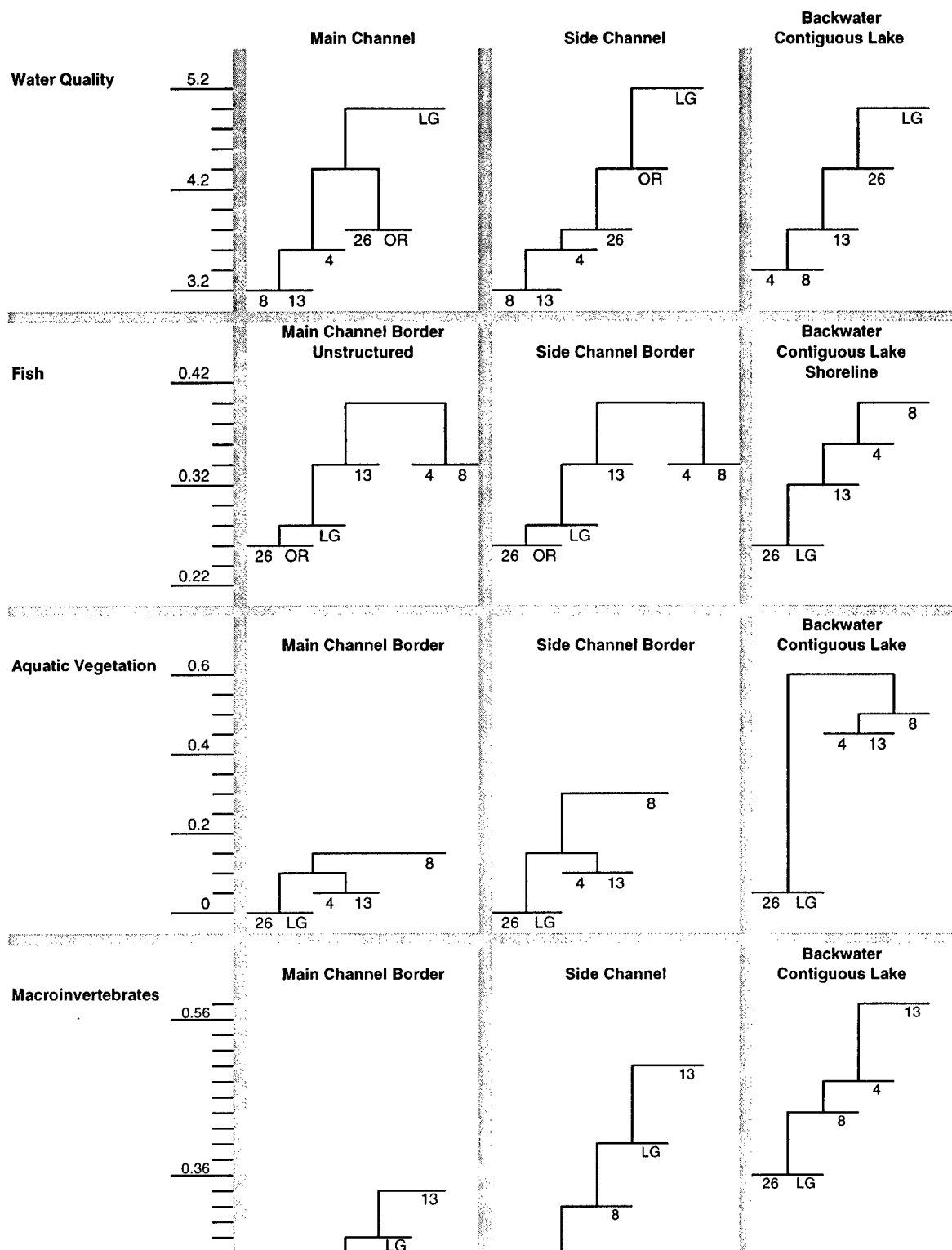


Figure 9. Similarities, as expressed by cluster analysis, among the trend analysis areas across components and aquatic area categories. Vertical scale values (Euclidean distances for water quality; correlation coefficients for other components) are only conservatively comparable because of the different sample sizes among aquatic area categories and components. Fish results are based on day electrofishing samples. Aquatic vegetation results are based on floristic and abundance features. Macroinvertebrate results are based on presence/absence of data.

analyses were selected from many that were available because they reflected general trends seen in the results and because they included five or six trend analysis areas. Many of the other analyses clustered four or fewer trend analysis areas because not all of the trend analysis areas included the same aquatic area categories.

Cluster analyses of numerous physical and biological variables indicated that, for macroinvertebrates, there was no obvious relation among trend analysis areas (Figure 9). However, for all other components, either the upper trend analysis areas (Navigation Pools 4, 8, and 13) or the lower trend analysis areas (Navigation Pool 26, Open River, La Grange Pool) clustered together first, indicating greater similarity within these two groups than between them. For example, analyses based on water quality generally clustered the upper trend analysis areas first, followed by the lower trend analysis areas. Analyses based on fish and aquatic vegetation clustered the lower trend analysis areas first. The only discrepancy noted in this pattern was that the fish component in Navigation Pool 13 was sometimes more similar to the lower trend analysis areas than to Navigation Pools 4 and 8 (e.g., main channel border shoreline and side channel border aquatic areas, Figure 9). Our results agree with similar analyses performed by Callahan (1998).

Multiyear Patterns from Trend Analysis Areas

A comparison of multiyear patterns in turbidity and aquatic vegetation illustrated that some variables tend to exhibit closely synchronized patterns across trend analysis areas, whereas others appear to be unrelated. Turbidity, for example, which often shows a seasonal pattern because of its dependence on flow, exhibited similar patterns in the three upper trend analysis areas (Figure 10). This similarity reflects the proximity of these trend analysis areas to each other and the dominant influence of main stem hydrologic factors (basin rainfall, soil erosion, sediment loading) to turbidity levels throughout the reach. The lower trend analysis areas showed less similarity, in part, because of downstream tributaries that drain large

basins and present a greater potential for different rainfall patterns and sediment loads.

Temporal patterns in the frequency of occurrence of aquatic vegetation along transects, however, suggested that few similarities exist, either among or within the impounded trend analysis areas (Figure 11). Aquatic vegetation response within these areas seems to be at least partly controlled by local conditions at each transect. The only major poolwide response apparent in the data was the vegetation decline in Navigation Pool 26 following the flood of 1993 (Figure 11, Redmond and Nelson 1994).

Aquatic vegetation responses, as illustrated in Figure 11, indicate that species and ecological processes associated with backwater habitats tend to be controlled by local factors as well as reachwide factors. In backwaters that are more isolated from the main channel, local factors are more likely to influence aquatic vegetation abundance than are reachwide factors.

Question 3: Are there gear or method redundancies in the Program?

Fish

For fish, electrofishing generally produced the highest power among gears in all trend analysis areas (Table 3, Appendix C), although some species were more effectively sampled by other gears (Appendixes C, D, and E). To investigate the potential for gear redundancies in the fish component, we used the results of power analysis to evaluate the effect of eliminating all passive fishing gears on the total number of species for which we could adequately measure annual change at the trend analysis area scale. The same criterion for power adequacy was used (i.e., a power of 0.70 to detect a 20% annual change in mean CPUE at $\alpha = 0.05$). If we eliminated passive gears, the number of species for which we would have adequate power declined from 41 to 37. The four species involved were northern pike, longnose gar, bowfin, and pugnose minnow.

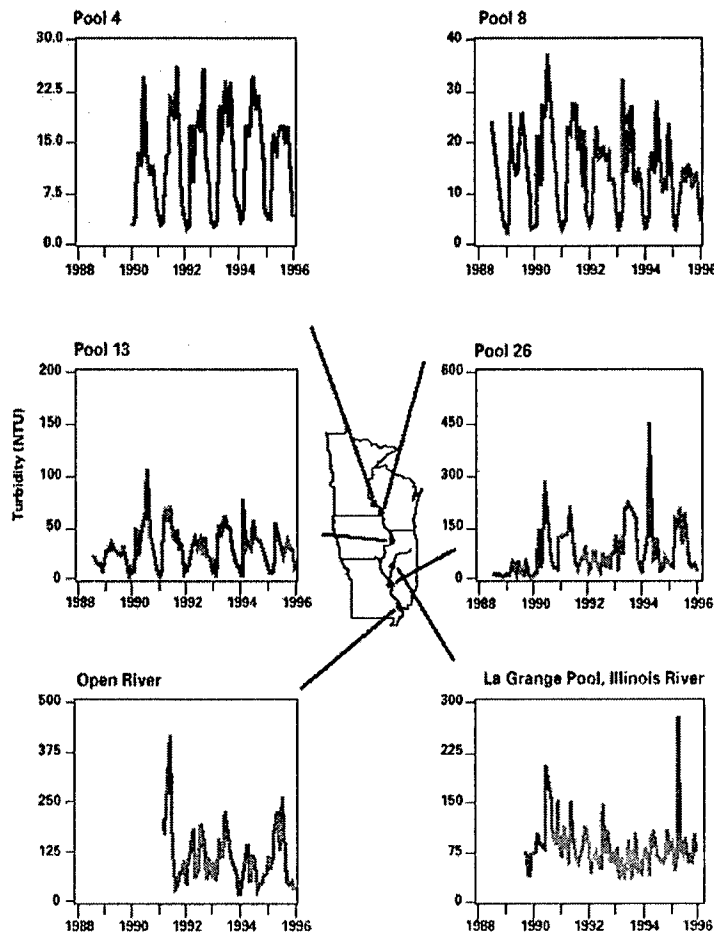


Figure 10. Turbidity data from the six trend analysis areas of the Long Term Resource Monitoring Program.

Aquatic Vegetation

In 1998, we began experimenting with stratified random sampling for aquatic vegetation to provide better poolwide estimates of the distribution and abundance of aquatic vegetation at shallow depths throughout each trend analysis area. Previously, sampling of vegetation was done along transects intended to reflect conditions in specific backwaters or impounded areas, not an entire trend analysis area.

Power curves suggested that both methods were limited for detecting rare species. In an individual backwater, Lawrence Lake (Navigation Pool 8), results from stratified random sampling ($n = 19$) produced similar estimates for the frequencies of common species and recorded 14 of the 16 species documented by transect sampling ($n = 441$,

Table 6). At the trend analysis area spatial scale, stratified random sampling was as effective as transect sampling at recording species richness.

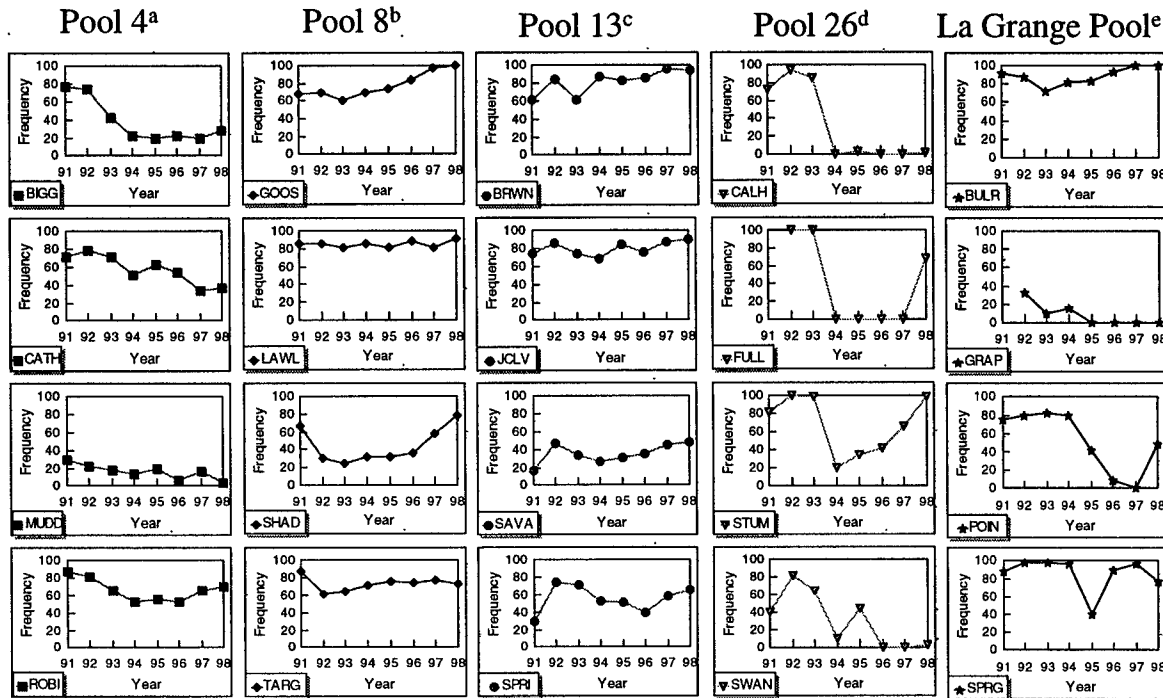
Analyses of several vegetation variables were conducted to explore the consequences of replacing transect sampling with stratified random sampling. The results were expressed for three individual backwaters and for both the aquatic area category and the trend analysis area spatial scales. Replacement of transect sampling would have no negative effects at the two broad spatial scales, but within specific backwaters our ability to detect changes in species richness, species abundance, and community abundance (the frequency of aquatic vegetation regardless of species) would be compromised.

Question 4: Are there target variable redundancies in the Program?

The question of target variable redundancies was directed at the suite of water-quality variables being monitored. Although there were significant correlations among many of the water-quality variables, the correspondence was not close enough (e.g., $R^2 > 0.70$) or consistent enough to consider one variable as a surrogate for another (Table 7). Several of the major cations (Na, Mg, Ca) showed relatively strong correlations with conductivity and among themselves. However, measurements for all three of these variables are produced from a single analysis of each water sample. Thus, elimination of any one of these variables would not reduce effort required for sampling or analysis.

Discussion

The initial data analyses completed in 1999 provide valuable information for considering future Program modifications. For example, even in the



- ^a Locations in Pool 4: BIGG = Big Lake, CATH = Catherine Pass, MUDD = Mud Lake, ROBI = Robinson Lake.
^b Locations in Pool 8: GOOS = Goose Island, LAWL = Lawrence Lake, SHAD = Shady Maple, TARG = Target Lake.
^c Locations in Pool 13: BRWN = Brown's Lake, JCLV = Johnson Creek Levee, SAVA = Savanna Bay, SPRI = Spring Lake.
^d Locations in Pool 26: CALH = Calhoun Point, FULL = Fuller Lake, STUM = Stump Lake, SWAN = Swan Lake.
^e Locations in La Grange Pool: BULR = Banner Marsh, GRAP = Grape Island, POIN = Point Lake, and SPRG = Spring Lake.

Figure 11. Aquatic vegetation response over 8 years at transects in five trend analysis areas. Frequency equals the percentage of sites that were vegetated along each transect. Vegetation response among transects varied substantially within each trend analysis area, with the exception of the uniform decline at all transects in Navigation Pool 26 following the flood of 1993. Transect codes and symbols are included in the lower left corner of each figure.

absence of a rigid power standard, the effort comparisons (halved, present, and doubled) included here are useful for assessing data adequacy under a variety of potential Program modification alternatives. However, we emphasize that the analyses presented in this report represent a first step in the evaluation of Program efficiency. Not completed yet, for instance, are important analyses of the relations among the ecosystem components monitored at the LTRMP.

Power levels for detecting seasonal and biweekly change of water-quality variables are presently adequate, and a doubling of effort would provide little increase in power. Some reduction or redistribution of water-quality effort may be practical and justified.

It is important not to over generalize when considering power levels for water-quality variables in the context of making Program planning decisions. First, reductions in water-quality sampling may affect our ability to make inferences about limiting conditions in small, local habitats within the trend analysis areas. Different combinations of water-quality variables may define the suitability of those habitats.

Second, the ecological significance of a 20% change in a seasonal mean (a common change detection criteria used in this report) varies among the water-quality variables. For example, a decline in soluble-reactive phosphorus from 0.20 to 0.16 mg/L can be produced by small variations in discharge regime or phytoplankton uptake, but the

Table 6. Percent frequency of occurrence for aquatic vegetation observed in Lawrence Lake (Navigation Pool 8) in 1998, using transect and stratified random sampling methods. N is sample size.

Species	Scientific name	Sampling method	
		Transects (n = 441)	Stratified random (n = 19)
Coontail	<i>Ceratophyllum demersum</i>	88	95
Canadian waterweed	<i>Elodea canadensis</i>	15	37
Eurasian watermilfoil	<i>Myriophyllum spicatum</i>	43	42
Nodding waterlily	<i>Najas flexilis</i>	14	42
Southern waterlily	<i>N. guadalupensis</i>	0.1	0
American lotus	<i>Nelumbo lutea</i>	16	21
Narrow-leaf pondweed	<i>Potamogeton foliosus</i> or <i>P. pusillus</i>	14	68
Yellow pondlily	<i>Nuphar lutea</i>	11	21
White waterlily	<i>Nymphaea odorata</i>	52	63
Curly pondweed	<i>Potamogeton crispus</i>	22	53
Long-leaf pondweed	<i>P. nodosus</i>	1	11
Sago pondweed	<i>P. pectinatus</i>	34	21
Flatstem pondweed	<i>P. zosteriformis</i>	9	47
Common bladderwort	<i>Utricularia macrorhiza</i>	13	31
Wild celery	<i>Vallisneria americana</i>	0.5	0
Water stargrass	<i>Heteranthera dubia</i>	10	11

planning decisions should consider power to detect change in any physical variable relative to its biological significance.

Our ability to detect change for the biological components was clearly related to two factors, sample size and the frequency of collection of different species (or the extent of defined habitats). The fact that the fish monitoring design

ecological consequences of this change may be nondetectable. However, a change in mean temperature from 20° to 16°C could easily affect the spawning success of a fish species. A shift in average dissolved oxygen from 5 to 4 mg/L could represent a substantial increase in the size of an area that experiences oxygen depletion. Ideally,

collected 132 of the 139 species historically reported from the sampled reaches is an indicator of success in addressing large-scale community composition. We were able to detect a 20% change (at $\alpha = 0.05$) in annual mean CPUE for 41 fish species within at least one trend analysis area. Therefore, it seems that the Program's fish

Table 7. Correlation matrix of the water-quality variables measured at stratified random sites of the Long Term Resource Monitoring Program.

Water-quality variables ^a	Temp	DO	Cond	Secchi	Turb	TSS	TN	NOX	TP	SRP
Temp	1.00	-0.53	-0.11	-0.47	0.16	0.22	-0.02	-0.18	0.21	0.00
DO		1.00	-0.05	0.25	-0.17	-0.24	-0.11	0.02	-0.24	-0.15
Cond			1.00	-0.07	0.03	0.01	0.41	0.45	0.20	0.40
Secchi				1.00	-0.27	-0.45	-0.15	-0.03	-0.26	-0.04
Turb					1.00	0.74	0.10	0.04	0.29	0.02
TSS						1.00	0.18	0.08	0.37	0.00
TN							1.00	0.68	0.14	0.22
NOX								1.00	0.00	0.17
TP									1.00	0.43
SRP										1.00

^aTemp = temperature; DO = dissolved oxygen; Cond = conductivity; Secchi = Secchi disk transparency; Turb = turbidity; TSS = total suspended solids; TN = total nitrogen; NOX = nitrate/nitrite; TP = total phosphorus; and SRP = soluble-reactive phosphorus.

community approach to sampling also adequately documents changes in many individual species at present levels of effort. A doubling of fish sampling effort would not appreciably enhance power for rare species.

Power results and cluster analyses suggested that some reductions in the fish sampling effort could be implemented with little loss of information. The specific consequences of selected options for reducing effort, such as eliminating passive or apparent duplicative gears, merit further examination.

Power levels associated with historical transect sampling for aquatic vegetation were adequate. In contrast, the low power levels for detecting change in macroinvertebrates, especially in Navigation Pool 26, Open River, and La Grange Pool trend analysis reaches should prompt further analysis and alternative sampling strategies. The comparison of annual and every third-year sampling intervals for mayflies indicated that sampling at less than annual intervals would reduce our ability to rapidly detect short-term change.

Cluster analyses generally indicated greater similarity within the three upper and the three lower trend analysis areas than among them. Biological conditions and responses at several spatial scales will remain of interest within the Program, but fully effective monitoring at each scale is unlikely to be affordable. The change in the aquatic vegetation design from transect to stratified random sampling illustrates a case where both methods provide valuable information, but each is most effective at a different spatial scale. Early results suggest that stratified random vegetation sampling will improve our ability to make poolwide inferences and will maintain the Program's ability to track the frequency of occurrence of most common species at the aquatic area category scale, although there will be fewer observations in individual backwaters.

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References

- Callahan, E. 1998. Similarities between Upper Mississippi River pools included in the Long Term Resource Monitoring Program (LTRMP). Report submitted to the Environmental Management Technical Center, U.S. Geological Survey, Onalaska, Wisconsin. 13 pp. + Appendixes.
- Fremling, C. R., J. L. Rasmussen, R. E. Sparks, S. P. Cobb, C. F. Bryan, and T. O. Claflin. 1989. Pages 309–351 in D. P. Dodge, editor. Mississippi River fisheries: A case history. Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences 106.
- Gibbs, J. P., S. Droege, and P. Eagle. 1998. Computers in biology. Monitoring populations of plants and animals. *BioScience* 48:935–940.
- Gutreuter, S., R. Burkhardt, and K. Lubinski. 1995. Long Term Resource Monitoring Program Procedures: Fish monitoring. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, July 1995. LTRMP 95-P002-1. 42 pp. + Appendixes A–J.
- Jackson, G. A., C. E. Korschgen, P. A. Thiel, J. M. Besser, D. W. Steffek, and M. H. Bockenhauer. 1981. A Long Term Resource Monitoring Plan for the Upper Mississippi River System. Contract Number 14-16-009-81-903. Upper Mississippi River Basin Commission, Bloomington, Minnesota. 2 vols.

- Johnson, D. H. 1999. The insignificance of statistical significance testing. *Journal of Wildlife Management* 63:763–772.
- Lubinski, K. 1993. A conceptual model of the Upper Mississippi River System ecosystem. U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin. EMTC 93-T001. 23 pp.
- Peterman, R. M. 1990. Statistical power analysis can improve fisheries research and management. *Canadian Journal of Fisheries and Aquatic Sciences* 47:2–15.
- Rasmussen, J. L. 1979. A compendium of fishery information on the Upper Mississippi River. 2nd edition. Upper Mississippi River Conservation Committee Special Publication. Rock Island, Illinois. 259 pp.
- Redmond, A. S., and J. C. Nelson. 1994. Observations on submersed aquatic vegetation in three backwater lakes of the lower Illinois River before and after the 1993 flood. Pages 17–29 in National Biological Service, Illinois Natural History Survey, Iowa Department of Natural Resources, and Wisconsin Department of Natural Resources. 1994. Long Term Resource Monitoring Program 1993 flood observations. National Biological Service, Environmental Management Technical Center, Onalaska, Wisconsin, December 1994. LTRMP 94-S011. 191 pp.
- Robins, C. R., C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott. 1991. Common and scientific names of fishes from the United States and Canada. 5th edition. Special Publication 20. American Fisheries Society, Bethesda, Maryland. 183 pp.
- Soballe, D. M., R. Burkhardt, K. Lubinski, R. Burdis, T. Clemment, J. Fischer, L. Hodge-Richardson, L. Conaway, J. Frazier, D. Gould, M. Steuck, J. Arnold, E. Ratcliff, M. Sitzes, S. Stenzel, and R. Wright. 1995. Long Term Resource Monitoring Program Procedures: Water quality monitoring. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin. (Unpublished report)
- Soballe, D. M., and J. T. Rogala. 1996. Estimating the extent of suitable winter habitat in off-channel areas of the Upper Mississippi River system. Annual Meeting, Mississippi River Research Consortium, La Crosse, Wisconsin, April 25–26, 1996.
- Thiel, P. A., and J. S. Sauer. 1999. Long Term Resource Monitoring Program Procedures: Macroinvertebrate monitoring. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, Revised May 1999. LTRMP 95-P002-2. (Revised 1999) 7 pp. + Appendixes A–H
- Upper Mississippi River Conservation Committee. 1980. A guide to the design, development, and testing of a Monitoring Plan for the Upper Mississippi River System. Upper Mississippi River Conservation Committee, Rock Island, Illinois. 41 pp.
- U.S. Fish and Wildlife Service. 1987. Action Plan Report – Environmental Management Program Resource Trend Analysis. St. Paul, Minnesota. 23 pp. + Appendixes A–H.
- U.S. Fish and Wildlife Service. 1993. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002R. 179 pp.
- U.S. Geological Survey. 1999. Ecological status and trends of the Upper Mississippi River System 1998: A report of the Long Term Resource Monitoring Program. U.S. Geological Survey, Upper Midwest Environmental Sciences

- Center, La Crosse, Wisconsin. April 1999. LTRMP 99-T001. 236 pp.
- Onalaska, Wisconsin. EMTC 93-T003. 9 pp. + Appendix A.
- Venables, W. N., and B. D. Ripley. 1999. Modern applied statistics with S-plus. 3rd edition. Springer Verlag, New York.
- Wilcox, D. B. 1993. An aquatic habitat classification system for the Upper Mississippi River System. U.S. Fish and Wildlife Service, Environmental Management Technical Center,
- Yin, Y., J. S. Winkelman, and H. A. Langrehr. 2000. Long Term Resource Monitoring Program procedures: Aquatic vegetation monitoring. U.S. Geological Survey, Upper Midwest Environmental Sciences Center, La Crosse, Wisconsin, April 2000. LTRMP 95-P002-7. 8 pp. + Appendixes A-C.

Appendix A. Power Analyses for Water Quality

Appendix A contains 10 tables (A-1 to A-10), one for each water-quality variable, listing statistical power (at $\alpha = 0.20$) to detect a 20% annual change by season, aquatic area category, and trend analysis area at halved, present, and doubled levels of effort.

Table A-1. Power (at $\alpha = 0.20$) to detect a 20% change in temperature at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.27	0.37	0.52	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	0.20	0.26	0.35	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	0.22	0.28	0.39	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 8	BWC	0.22	0.30	0.41	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	IMP	0.21	0.25	0.34	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	0.24	0.37	0.53	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 13	SC	0.22	0.28	0.38	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	0.26	0.36	0.51	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	IMP	0.56	0.78	0.95	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 26	MC	0.43	0.59	0.80	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	0.61	0.81	0.96	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	0.26	0.35	0.49	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Open River	IMP	0.33	0.45	0.64	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	0.19	0.24	0.32	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	0.24	0.33	0.46	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
La Grange Pool	MC	0.42	0.60	0.81	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	0.38	0.53	0.74	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	0.59	0.80	0.96	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	0.27	0.36	0.51	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	0.40	0.57	0.78	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-2. Power (at $\alpha = 0.20$) to detect a 20% change in dissolved oxygen at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.69	0.89	0.99	>0.99	>0.99	>0.99	0.89	0.99	>0.99	>0.99	>0.99	>0.99
	MC	0.38	0.53	0.74	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 8	BWC	0.33	0.47	0.66	>0.99	>0.99	>0.99	0.58	0.80	0.96	0.93	>0.99	>0.99
	IMP	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 13	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	0.37	0.53	0.73	>0.99	>0.99	>0.99	0.78	0.95	>0.99	>0.99	>0.99	>0.99
	IMP	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.97	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 26	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	0.66	0.86	0.98	0.77	0.94	>0.99	0.49	0.69	0.89	0.62	0.84	0.97
Open River	IMP	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.44	0.61	0.82	0.78	0.94	>0.99
	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.93	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
La Grange Pool	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.94	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.96	>0.99	>0.99	>0.99	>0.99	>0.99
La Grange Pool	MC	0.72	0.91	0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.75	0.93	>0.99	>0.99	>0.99	>0.99

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-3. Power (at $\alpha = 0.20$) to detect a 20% change in conductivity at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.98	>0.99	>0.99	0.75	0.93	>0.99	0.94	>0.99	>0.99	0.86	0.98	>0.99
	MC	0.99	>0.99	>0.99	0.53	0.75	0.93	0.90	0.99	>0.99	0.71	0.91	0.99
	SC	>0.99	>0.99	>0.99	0.81	0.96	>0.99	0.87	0.98	>0.99	0.76	0.93	>0.99
Pool 8	BWC	0.97	>0.99	>0.99	0.97	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	IMP	>0.99	>0.99	>0.99	0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 13	SC	>0.99	>0.99	>0.99	0.97	>0.99	>0.99	>0.99	>0.99	>0.99	0.97	>0.99	>0.99
	BWC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	IMP	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
Pool 26	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	0.86	0.98	>0.99	0.93	0.99	>0.99	>0.99	>0.99	>0.99	0.98	>0.99	>0.99
Open River	IMP	0.95	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	MC	0.73	0.91	0.99	0.98	>0.99	>0.99	0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	0.76	0.94	>0.99	0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
La Grange Pool	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
La Grange Pool	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	SC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99
	BWC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-4. Power (at $\alpha = 0.20$) to detect a 20% change in Secchi disk transparency at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.70	0.90	0.99	0.99	>0.99	>0.99	0.90	0.99	>0.99	0.74	0.93	>0.99
	MC	0.65	0.86	0.98	0.98	0.90	0.99	0.34	0.49	0.69	0.50	0.70	0.90
	SC	0.40	0.56	0.77	0.86	0.98	>0.99	0.42	0.61	0.82	0.57	0.78	0.95
Pool 8	BWC	0.53	0.74	0.92	0.99	>0.99	>0.99	0.84	0.97	>0.99	0.88	0.99	>0.99
	IMP	0.66	0.86	0.98	>0.99	>0.99	>0.99	0.85	0.98	>0.99	0.96	>0.99	>0.99
	MC	0.71	0.90	0.99	>0.99	>0.99	>0.99	0.93	>0.99	>0.99	0.98	>0.99	>0.99
Pool 13	SC	0.51	0.71	0.91	>0.99	>0.99	>0.99	0.89	0.99	>0.99	0.92	0.99	>0.99
	BWC	0.60	0.80	0.96	0.98	>0.99	>0.99	0.89	0.99	>0.99	0.92	0.99	>0.99
	IMP	0.42	0.59	0.81	0.91	0.99	>0.99	0.65	0.86	0.98	0.71	0.91	0.99
Pool 26	MC	0.73	0.92	0.99	0.89	0.99	>0.99	0.98	>0.99	>0.99	0.98	>0.99	>0.99
	SC	0.44	0.61	0.82	0.98	>0.99	>0.99	0.99	>0.99	>0.99	0.97	>0.99	>0.99
	BWC	0.51	0.70	0.90	0.44	0.62	0.83	0.59	0.79	0.95	0.60	0.82	0.96
Open River	IMP	0.41	0.58	0.79	0.68	0.89	0.99	0.69	0.89	0.99	0.97	>0.99	>0.99
	MC	0.29	0.39	0.56	0.43	0.62	0.83	0.67	0.87	0.98	0.83	0.97	>0.99
	SC	0.48	0.68	0.88	0.78	0.95	>0.99	0.97	>0.99	>0.99	0.97	>0.99	>0.99
La Grange Pool	MC	0.95	>0.99	>0.99	0.97	>0.99	>0.99	0.71	0.90	0.99	>0.99	>0.99	>0.99
	SC	0.66	0.87	0.98	0.96	>0.99	>0.99	0.68	0.88	0.99	0.88	0.98	>0.99
	BWC	0.97	>0.99	>0.99	0.99	>0.99	>0.99	0.83	0.97	>0.99	0.98	>0.99	>0.99
	MC	0.73	0.92	0.99	0.73	0.91	0.99	0.47	0.66	0.87	0.94	>0.99	>0.99
	SC	0.90	0.99	>0.99	0.95	>0.99	>0.99	0.64	0.85	0.98	0.84	0.98	>0.99

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-5. Power (at $\alpha = 0.20$) to detect a 20% change in turbidity at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.48	0.68	0.88	0.60	0.81	0.96	0.49	0.69	0.89	0.38	0.55	0.76
	MC	0.65	0.86	0.98	0.44	0.64	0.85	0.27	0.37	0.52	0.37	0.53	0.74
	SC	0.55	0.75	0.93	0.48	0.68	0.89	0.32	0.44	0.63	0.45	0.64	0.85
Pool 8	BWC	0.32	0.46	0.65	0.77	0.94	>0.99	0.47	0.66	0.87	0.52	0.73	0.92
	IMP	0.65	0.85	0.98	0.83	0.97	>0.99	0.62	0.83	0.97	0.69	0.90	0.99
	MC	0.57	0.78	0.95	0.78	0.94	>0.99	0.93	>0.99	>0.99	0.81	0.96	>0.99
Pool 13	SC	0.48	0.67	0.87	0.82	0.97	>0.99	0.77	0.94	>0.99	0.76	0.94	>0.99
	BWC	0.49	0.68	0.89	0.72	0.91	0.99	0.57	0.78	0.95	0.75	0.93	>0.99
	IMP	0.61	0.82	0.97	0.59	0.81	0.96	0.43	0.62	0.83	0.59	0.80	0.96
Pool 26	MC	0.84	0.97	>0.99	0.84	0.97	>0.99	0.83	0.97	>0.99	0.90	0.99	>0.99
	SC	0.52	0.73	0.92	0.94	>0.99	>0.99	0.94	>0.99	>0.99	0.65	0.86	0.98
	BWC	0.28	0.39	0.56	0.24	0.33	0.46	0.35	0.48	0.68	0.38	0.54	0.75
Open River	IMP	0.26	0.37	0.52	0.30	0.41	0.58	0.39	0.55	0.77	0.59	0.78	0.95
	MC	0.24	0.31	0.43	0.34	0.48	0.68	0.46	0.64	0.85	0.51	0.72	0.91
	SC	0.28	0.39	0.55	0.54	0.75	0.93	0.61	0.83	0.97	0.68	0.88	0.99
La Grange Pool	MC	0.80	0.96	>0.99	0.76	0.94	>0.99	0.58	0.79	0.95	>0.99	>0.99	>0.99
	SC	0.50	0.70	0.90	0.78	0.95	>0.99	0.32	0.44	0.63	0.63	0.83	0.97
	BWC	0.69	0.89	0.99	0.89	0.99	>0.99	0.68	0.88	0.99	0.78	0.95	>0.99
La Grange Pool	MC	0.50	0.70	0.90	0.55	0.76	0.94	0.35	0.49	0.69	0.76	0.93	>0.99
	SC	0.66	0.87	0.98	0.61	0.82	0.96	0.35	0.48	0.68	0.56	0.78	0.95

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-6. Power (at $\alpha = 0.20$) to detect a 20% change in total suspended solids at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.32	0.44	0.63	0.39	0.55	0.76	0.38	0.54	0.75	0.29	0.40	0.56
	MC	0.73	0.91	0.99	0.29	0.39	0.56	0.22	0.29	0.40	0.24	0.33	0.47
	SC	0.43	0.61	0.82	0.37	0.52	0.73	0.27	0.36	0.51	0.29	0.39	0.55
Pool 8	BWC	0.27	0.37	0.53	0.65	0.85	0.98	0.46	0.64	0.85	0.36	0.52	0.72
	IMP	0.54	0.74	0.93	0.42	0.59	0.80	0.50	0.69	0.89	0.38	0.53	0.74
	MC	0.29	0.40	0.57	0.40	0.56	0.77	0.81	0.96	>0.99	0.71	0.91	0.99
Pool 13	SC	0.34	0.47	0.67	0.48	0.69	0.89	0.56	0.77	0.94	0.56	0.78	0.95
	BWC	0.36	0.50	0.70	0.50	0.70	0.90	0.42	0.59	0.81	0.67	0.87	0.98
	IMP	0.30	0.42	0.60	0.41	0.58	0.79	0.32	0.45	0.64	0.40	0.56	0.78
Pool 26	MC	0.33	0.46	0.65	0.64	0.85	0.98	0.60	0.81	0.96	0.76	0.93	>0.99
	SC	0.35	0.49	0.69	0.69	0.89	0.99	0.71	0.91	0.99	0.86	0.98	>0.99
	BWC	0.28	0.40	0.56	0.26	0.35	0.49	0.32	0.45	0.63	0.29	0.40	0.57
Open River	IMP	0.24	0.33	0.47	0.26	0.35	0.49	0.30	0.42	0.59	0.38	0.52	0.72
	MC	0.21	0.26	0.35	0.32	0.46	0.65	0.37	0.54	0.75	0.30	0.43	0.61
	SC	0.27	0.36	0.51	0.49	0.69	0.89	0.50	0.71	0.90	0.46	0.66	0.87
La Grange Pool	MC	0.85	0.98	>0.99	0.75	0.93	>0.99	0.54	0.75	0.93	0.89	0.99	>0.99
	SC	0.39	0.56	0.77	0.81	0.96	>0.99	0.35	0.49	0.69	0.50	0.70	0.90
	BWC	0.43	0.61	0.82	0.62	0.83	0.97	0.42	0.60	0.81	0.32	0.45	0.63
La Grange Pool	MC	0.39	0.55	0.76	0.48	0.68	0.88	0.27	0.37	0.52	0.48	0.66	0.87
	SC	0.35	0.49	0.69	0.42	0.60	0.82	0.23	0.29	0.41	0.34	0.47	0.67

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-7. Power (at $\alpha = 0.20$) to detect a 20% change in total phosphorus at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.44	0.62	0.84	0.71	0.89	0.99	0.69	0.90	0.99	0.55	0.75	0.93
	MC	0.74	0.93	>0.99	0.39	0.57	0.78	0.68	0.89	0.99	0.53	0.75	0.93
	SC	0.74	0.93	>0.99	0.61	0.81	0.96	0.62	0.82	0.96	0.63	0.86	0.98
Pool 8	BWC	0.30	0.42	0.59	0.71	0.91	0.99	0.39	0.56	0.77	0.37	0.52	0.72
	IMP	0.72	0.92	0.99	0.63	0.82	0.96	0.92	0.99	>0.99	0.31	0.41	0.58
	MC	0.71	0.91	0.99	0.73	0.91	0.99	0.61	0.82	0.97	0.38	0.53	0.74
Pool 13	SC	0.74	0.93	>0.99	0.70	0.91	0.99	0.54	0.75	0.93	0.38	0.54	0.75
	BWC	0.36	0.51	0.71	0.64	0.84	0.97	0.35	0.49	0.69	0.63	0.84	0.98
	IMP	0.40	0.56	0.77	0.52	0.71	0.91	0.28	0.38	0.54	0.36	0.52	0.73
Pool 26	MC	0.62	0.83	0.97	0.49	0.68	0.88	0.25	0.34	0.48	0.84	0.98	>0.99
	SC	0.40	0.57	0.78	0.50	0.70	0.90	0.23	0.31	0.43	0.72	0.91	0.99
	BWC	0.21	0.27	0.37	0.32	0.45	0.64	0.26	0.36	0.51	0.28	0.39	0.56
Open River	IMP	0.30	0.43	0.61	0.34	0.48	0.68	0.20	0.27	0.37	0.30	0.43	0.61
	MC	0.34	0.49	0.69	0.49	0.67	0.87	0.25	0.34	0.47	0.47	0.69	0.89
	SC	0.36	0.51	0.71	0.76	0.94	>0.99	0.38	0.55	0.76	0.75	0.92	>0.99
La Grange Pool	MC	0.93	0.99	>0.99	0.64	0.85	0.98	0.37	0.52	0.73	0.66	0.86	0.98
	SC	0.84	0.97	>0.99	0.51	0.72	0.91	0.30	0.42	0.60	0.43	0.62	0.83
	BWC	0.42	0.59	0.80	0.67	0.87	0.98	0.49	0.69	0.89	0.41	0.59	0.81
La Grange Pool	MC	0.86	0.97	>0.99	0.70	0.89	0.99	0.51	0.70	0.90	0.75	0.93	>0.99
	SC	0.47	0.67	0.88	0.60	0.78	0.95	0.41	0.56	0.77	0.67	0.87	0.98

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-8. Power (at $\alpha = 0.20$) to detect a 20% change in soluble-reactive phosphorus at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.23	0.31	0.43	0.70	0.89	0.99	0.20	0.26	0.35	0.17	0.21	0.27
	MC	0.29	0.38	0.54	0.34	0.46	0.66	0.21	0.27	0.36	0.23	0.30	0.41
	SC	0.31	0.43	0.61	0.33	0.45	0.64	0.23	0.30	0.41	0.28	0.41	0.58
Pool 8	BWC	0.24	0.33	0.46	0.37	0.53	0.74	0.21	0.27	0.37	0.19	0.25	0.33
	IMP	0.37	0.55	0.76	0.34	0.47	0.67	0.27	0.36	0.52	0.47	0.68	0.88
	MC	0.28	0.39	0.55	0.19	0.25	0.33	0.20	0.27	0.36	0.73	0.91	0.99
Pool 13	SC	0.35	0.48	0.68	0.36	0.49	0.69	0.21	0.27	0.37	0.64	0.88	0.99
	BWC	0.22	0.30	0.41	0.65	0.86	0.98	0.38	0.53	0.74	0.22	0.28	0.38
	IMP	0.35	0.48	0.67	0.33	0.48	0.67	0.20	0.26	0.35	0.32	0.46	0.65
Pool 26	MC	0.58	0.79	0.95	0.44	0.63	0.84	0.26	0.35	0.50	0.27	0.38	0.54
	SC	0.24	0.32	0.45	0.41	0.59	0.81	0.29	0.40	0.56	0.25	0.35	0.49
	BWC	0.16	0.19	0.24	0.21	0.27	0.36	0.17	0.22	0.28	0.14	0.15	0.18
Open River	IMP	0.16	0.20	0.25	0.20	0.24	0.32	0.14	0.15	0.18	0.18	0.20	0.26
	MC	0.22	0.29	0.40	0.23	0.29	0.40	0.20	0.25	0.33	0.20	0.25	0.34
	SC	0.20	0.25	0.34	0.22	0.29	0.40	0.26	0.35	0.49	0.17	0.20	0.26
La Grange Pool	MC	0.59	0.81	0.96	0.49	0.69	0.89	0.33	0.46	0.65	0.45	0.65	0.86
	SC	0.44	0.63	0.84	0.45	0.63	0.85	0.27	0.36	0.51	0.21	0.27	0.37
	BWC	0.22	0.28	0.39	0.38	0.54	0.75	0.28	0.38	0.54	0.19	0.23	0.31
La Grange Pool	MC	0.54	0.73	0.92	0.39	0.54	0.74	0.61	0.83	0.97	0.51	0.67	0.88
	SC	0.39	0.56	0.78	0.28	0.39	0.55	0.25	0.34	0.48	0.18	0.24	0.32

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-9. Power (at $\alpha = 0.20$) to detect a 20% change in total nitrogen at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.63	0.84	0.97	0.49	0.68	0.88	0.47	0.68	0.88	0.40	0.56	0.77
	MC	0.69	0.90	0.99	0.46	0.67	0.87	0.55	0.77	0.94	0.26	0.36	0.51
	SC	0.99	>0.99	>0.99	0.30	0.41	0.58	0.61	0.81	0.96	0.35	0.50	0.71
Pool 8	BWC	0.52	0.72	0.91	0.68	0.88	0.99	0.51	0.71	0.91	0.78	0.94	>0.99
	IMP	0.75	0.94	>0.99	0.87	0.98	>0.99	0.74	0.91	0.99	0.95	>0.99	>0.99
	MC	>0.99	>0.99	>0.99	0.73	0.91	0.99	0.64	0.87	0.98	0.49	0.68	0.89
Pool 13	SC	0.92	0.99	>0.99	0.90	0.99	>0.99	0.87	0.98	>0.99	0.84	0.98	>0.99
	BWC	0.44	0.62	0.83	0.69	0.88	0.99	0.82	0.97	>0.99	0.80	0.96	>0.99
	IMP	0.55	0.75	0.93	0.63	0.82	0.97	0.88	0.99	>0.99	0.98	>0.99	>0.99
Pool 26	MC	0.64	0.84	0.97	0.51	0.70	0.90	0.93	>0.99	>0.99	0.81	0.96	>0.99
	SC	0.87	0.98	>0.99	0.87	0.98	>0.99	0.88	0.99	>0.99	0.95	>0.99	>0.99
	BWC	0.22	0.30	0.41	0.39	0.57	0.78	0.28	0.39	0.55	0.47	0.67	0.87
Open River	IMP	0.27	0.39	0.56	0.37	0.54	0.75	0.51	0.75	0.93	0.52	0.74	0.93
	MC	0.49	0.70	0.90	0.62	0.81	0.96	0.58	0.79	0.95	0.69	0.91	0.99
	SC	0.51	0.71	0.91	0.67	0.88	0.98	0.80	0.96	>0.99	0.97	>0.99	>0.99
La Grange Pool	MC	0.81	0.96	>0.99	0.80	0.96	>0.99	0.92	0.99	>0.99	0.81	0.96	>0.99
	SC	0.66	0.87	0.98	0.99	>0.99	>0.99	0.58	0.79	0.95	0.57	0.79	0.95
	BWC	0.40	0.58	0.79	0.86	0.98	>0.99	0.94	>0.99	>0.99	0.72	0.91	0.99
La Grange Pool	MC	>0.99	>0.99	>0.99	>0.99	>0.99	>0.99	0.73	0.91	0.99	>0.99	>0.99	>0.99
	SC	0.98	>0.99	>0.99	>0.99	>0.99	>0.99	0.72	0.89	0.99	0.81	0.96	>0.99

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

Table A-10. Power (at $\alpha = 0.20$) to detect a 20% change in nitrate/nitrite at halved, present, and doubled levels of effort by aquatic area category (grouped by trend analysis area) and season.

Trend analysis area	Aquatic area category ^a	Winter			Spring			Summer			Fall		
		Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort	Halved effort	Present effort	Doubled effort
Pool 4	BWC	0.36	0.50	0.70	0.29	0.39	0.56	0.25	0.35	0.49	0.24	0.32	0.44
	MC	0.99	>0.99	>0.99	0.42	0.62	0.83	0.42	0.59	0.80	0.17	0.21	0.27
	SC	>0.99	>0.99	>0.99	0.58	0.77	0.94	0.35	0.49	0.69	0.20	0.26	0.35
Pool 8	BWC	0.37	0.54	0.75	0.26	0.35	0.49	0.26	0.34	0.48	0.22	0.29	0.40
	IMP	0.54	0.76	0.94	0.64	0.83	0.97	0.69	0.89	0.99	0.58	0.79	0.95
	MC	0.99	>0.99	>0.99	0.50	0.68	0.88	0.48	0.66	0.87	0.51	0.69	0.89
Pool 13	SC	0.94	>0.99	>0.99	0.57	0.79	0.95	0.74	0.92	>0.99	0.34	0.48	0.67
	BWC	0.22	0.29	0.40	0.40	0.56	0.78	0.27	0.36	0.51	0.29	0.39	0.55
	IMP	0.73	0.91	>0.99	0.30	0.40	0.57	0.41	0.57	0.78	0.87	0.98	>0.99
Pool 26	MC	0.99	>0.99	>0.99	0.26	0.34	0.48	0.56	0.76	0.94	0.60	0.79	0.95
	SC	0.83	0.97	>0.99	0.50	0.69	0.89	0.23	0.30	0.42	0.56	0.79	0.95
	BWC	0.15	0.19	0.23	0.17	0.21	0.27	0.14	0.17	0.20	0.15	0.17	0.21
Open River	IMP	0.71	0.93	>0.99	0.36	0.53	0.74	0.29	0.39	0.55	0.29	0.42	0.59
	MC	0.82	0.97	>0.99	0.41	0.56	0.77	0.54	0.73	0.92	0.91	0.99	>0.99
	SC	0.30	0.41	0.58	0.42	0.59	0.80	0.59	0.80	0.96	0.81	0.96	>0.99
La Grange Pool	MC	>0.99	>0.99	>0.99	0.53	0.74	0.92	>0.99	>0.99	>0.99	0.64	0.85	0.98
	SC	0.78	0.94	>0.99	0.80	0.96	>0.99	0.95	>0.99	>0.99	0.27	0.37	0.53
	BWC	0.26	0.35	0.50	0.38	0.54	0.75	0.27	0.36	0.51	0.14	0.16	0.19
La Grange Pool	MC	>0.99	>0.99	>0.99	0.20	0.26	0.35	0.56	0.78	0.95	>0.99	>0.99	>0.99
	SC	0.99	>0.99	>0.99	0.99	>0.99	>0.99	0.45	0.65	0.86	0.24	0.29	0.41

^aBWC = backwater contiguous lake, IMP = backwater contiguous impounded, MC = main channel, SC = side channel.

**Appendix B. List of Fish Collected by the Long Term
Resource Monitoring Program**

Table B. List of fish collected by the Long Term Resource Monitoring Program, arranged phylogenetically by family, then alphabetically by genus and species. Hybrids are listed after their respective genera. Nomenclature follows Robins et al. (1991).

Common name	Family name	Scientific name
Petromyzontidae		
Chestnut lamprey		<i>Ichthyomyzon castaneus</i>
Silver lamprey		<i>I. unicuspis</i>
American brook lamprey		<i>Lampetra appendix</i>
Acipenseridae		
Lake sturgeon		<i>Acipenser fulvescens</i>
Pallid sturgeon		<i>Scaphirhynchus albus</i>
Shovelnose sturgeon		<i>S. platyrhynchus</i>
Pallid sturgeon × Shovelnose sturgeon		<i>S. albus</i> × <i>S. platyrhynchus</i>
Polyodontidae		
Paddlefish		<i>Polyodon spathula</i>
Lepisosteidae		
Spotted gar		<i>Lepisosteus oculatus</i>
Longnose gar		<i>L. osseus</i>
Shortnose gar		<i>L. platostomus</i>
Amiidae		
Bowfin		<i>Amia calva</i>
Hiodontidae		
Goldeye		<i>Hiodon alosoides</i>
Mooneye		<i>H. tergisus</i>
Anguillidae		
American eel		<i>Anguilla rostrata</i>
Clupeidae		
Skipjack herring		<i>Alosa chrysochloris</i>
Gizzard shad		<i>Dorosoma cepedianum</i>
Threadfin shad		<i>D. petenense</i>
Cyprinidae		
Central stoneroller		<i>Camptostoma anomalum</i>
Goldfish		<i>Carassius auratus</i>
Grass carp		<i>Ctenopharyngodon idella</i>
Red shiner		<i>Cyprinella lutrensis</i>
Spotfin shiner		<i>C. spiloptera</i>
Blacktail shiner		<i>C. venusta</i>
Common carp		<i>Cyprinus carpio</i>

Table B. Continued

Common name	Family name	Scientific name
Goldfish × common carp		<i>Carassius auratus</i> × <i>C. carpio</i>
Western silvery minnow		<i>Hybognathus argyritis</i>
Brassy minnow		<i>H. hankinsoni</i>
Mississippi silvery minnow		<i>H. nuchalis</i>
Plains minnow		<i>H. placitus</i>
Silver carp		<i>Hypophthalmichthys molitrix</i>
Bighead carp		<i>H. nobilis</i>
Striped shiner		<i>Luxilus chrysocephalus</i>
Bleeding shiner		<i>Luxilus zonatus</i>
Speckled chub		<i>Macrhybopsis aestivalis</i>
Sturgeon chub		<i>M. gelida</i>
Sicklefin chub		<i>M. meeki</i>
Silver chub		<i>M. storeriana</i>
Hornyhead chub		<i>Nocomis biguttatus</i>
Golden shiner		<i>Notemigonus crysoleucas</i>
Bigeye chub		<i>Notropis amblops</i>
Pallid shiner		<i>N. amnis</i>
Emerald shiner		<i>N. atherinoides</i>
River shiner		<i>N. blennius</i>
Bigeye shiner		<i>N. boops</i>
Ghost shiner		<i>N. buechanani</i>
Spottail shiner		<i>N. hudsonius</i>
Ozark minnow		<i>N. nubilus</i>
Silverband shiner		<i>N. shumardi</i>
Sand shiner		<i>N. stramineus</i>
Weed shiner		<i>N. texanus</i>
Mimic shiner		<i>N. volucellus</i>
Channel shiner		<i>N. wickliffi</i>
Pugnose minnow		<i>Opsopoeodus emiliae</i>
Suckermouth minnow		<i>Phenacobius mirabilis</i>
Southern redbelly dace		<i>P. erythrogaster</i>
Bluntnose minnow		<i>Pimephales notatus</i>
Fathead minnow		<i>P. promelas</i>
Bullhead minnow		<i>P. vigilax</i>
Blacknose dace		<i>Rhinichthys atratulus</i>
Creek chub		<i>Semotilus atromaculatus</i>
Catostomidae		
River carpsucker		<i>Carpionodes carpio</i>
Quillback		<i>C. cyprinus</i>
Highfin carpsucker		<i>C. velifer</i>
White sucker		<i>C. commersoni</i>
Blue sucker		<i>Cycleptus elongatus</i>
Creek chubsucker		<i>Erismyzon oblongus</i>
Northern hog sucker		<i>Hypentelium nigricans</i>
Smallmouth buffalo		<i>Ictiobus bubalus</i>
Bigmouth buffalo		<i>I. cyprinellus</i>
Black buffalo		<i>I. niger</i>
Spotted sucker		<i>Minytrema melanops</i>
Silver redbhorse		<i>Moxostoma anisurum</i>
River redbhorse		<i>M. carinatum</i>
Golden redbhorse		<i>M. erythrurum</i>
Shorthead redbhorse		<i>M. macrolepidotum</i>

Table B. Continued

Common name	Family name	Scientific name
Ictaluridae		
Black bullhead		<i>Ameiurus melas</i>
Yellow bullhead		<i>A. natalis</i>
Brown bullhead		<i>A. nebulosus</i>
Blue catfish		<i>Ictalurus furcatus</i>
Channel catfish		<i>I. punctatus</i>
Slender madtom		<i>Noturus exilis</i>
Stonecat		<i>N. flavus</i>
Tadpole madtom		<i>N. gyrinus</i>
Freckled madtom		<i>N. nocturnus</i>
Flathead catfish		<i>Pylodictis olivaris</i>
Esocidae		
Grass pickerel		<i>Esox americanus vermiculatus</i>
Northern pike		<i>E. lucius</i>
Muskellunge		<i>E. masquinongy</i>
Tiger muskellunge		<i>E. masquinongy</i> × <i>E. lucius</i>
Chain pickerel		<i>E. niger</i>
Umbridae		
Central mudminnow		<i>Umbra limi</i>
Osmeridae		
Rainbow smelt		<i>Osmerus mordax</i>
Salmonidae		
Brown trout		<i>Salmo trutta</i>
Percopsidae		
Trout-perch		<i>Percopsis omiscomaycus</i>
Aphredoderidae		
Pirate perch		<i>Aphredoderus sayanus</i>
Gadidae		
Burbot		<i>Lota lota</i>
Cyprinodontidae		
Northern studfish		<i>Fundulus catenatus</i>
Starhead topminnow		<i>F. dispar</i>
Blackstripe topminnow		<i>F. notatus</i>
Blackspotted topminnow		<i>F. olivaceus</i>

Table B. Continued

Common name	Family name	Scientific name
	Poeciliidae	
Western mosquitofish		<i>Gambusia affinis</i>
	Atherinidae	
Brook silverside		<i>Labidesthes sicculus</i>
Inland silverside		<i>Menidia beryllina</i>
	Gasterosteidae	
Brook stickleback		<i>Culaea inconstans</i>
	Percichthyidae	
White perch		<i>Morone americana</i>
White bass		<i>M. chrysops</i>
Yellow bass		<i>M. mississippiensis</i>
Striped bass		<i>M. saxatilis</i>
White bass × striped bass		<i>M. chrysops</i> × <i>M. saxatilis</i>
	Centrarchidae	
Shadow bass		<i>Ambloplites ariommus</i>
Rock bass		<i>A. rupestris</i>
Flier		<i>Centrarchus macropterus</i>
Green sunfish		<i>Lepomis cyanellus</i>
Pumpkinseed		<i>L. gibbosus</i>
Warmouth		<i>L. gulosus</i>
Orangespotted sunfish		<i>L. humilis</i>
Bluegill		<i>L. macrochirus</i>
Longear sunfish		<i>L. megalotis</i>
Redear sunfish		<i>L. microlophus</i>
Green sunfish × pumpkinseed		<i>L. cyanellus</i> × <i>L. gibbosus</i>
Green sunfish × warmouth		<i>L. cyanellus</i> × <i>L. gulosus</i>
Green sunfish × orangespotted sunfish		<i>L. cyanellus</i> × <i>L. humilis</i>
Green sunfish × bluegill		<i>L. cyanellus</i> × <i>L. macrochirus</i>
Pumpkinseed × warmouth		<i>L. gibbosus</i> × <i>L. gulosus</i>
Pumpkinseed × orangespotted sunfish		<i>L. gibbosus</i> × <i>L. humilis</i>
Pumpkinseed × bluegill		<i>L. gibbosus</i> × <i>L. macrochirus</i>
Orangespotted sunfish × longear sunfish		<i>L. humilis</i> × <i>L. megalotis</i>
Bluegill × warmouth		<i>L. macrochirus</i> × <i>L. gulosus</i>
Bluegill × orangespotted sunfish		<i>L. macrochirus</i> × <i>L. humilis</i>
Bluegill × longear sunfish		<i>L. macrochirus</i> × <i>L. megalotis</i>
Bluegill × reardear sunfish		<i>L. macrochirus</i> × <i>L. microlophus</i>
Smallmouth bass		<i>Micropterus dolomieu</i>
Spotted bass		<i>M. punctulatus</i>
Largemouth bass		<i>M. salmoides</i>
White crappie		<i>Pomoxis annularis</i>
Black crappie		<i>P. nigromaculatus</i>
White crappie × black crappie		<i>P. annularis</i> × <i>P. nigromaculatus</i>

Table B. Continued

Common name	Family name	Scientific name
Percidae		
Crystal darter		<i>Crystallaria asprella</i>
Western sand darter		<i>Ammocrypta clara</i>
Mud darter		<i>Etheostoma asprigene</i>
Greenside darter		<i>E. blennioides</i>
Bluntnose darter		<i>E. chlorosomum</i>
Iowa darter		<i>E. exile</i>
Fantail darter		<i>E. flabellare</i>
Slough darter		<i>E. gracile</i>
Johnny darter		<i>E. nigrum</i>
Banded darter		<i>E. zonale</i>
Yellow perch		<i>Perca flavescens</i>
Logperch		<i>Percina caprodes</i>
Blackside darter		<i>P. maculata</i>
Slenderhead darter		<i>P. phoxocephala</i>
Dusky darter		<i>P. sciera</i>
River darter		<i>P. shumardi</i>
Sauger		<i>Stizostedion canadense</i>
Walleye		<i>S. vitreum</i>
Sauger × walleye		<i>S. canadense</i> × <i>S. vitreum</i>
Sciaenidae		
Freshwater drum		<i>Aplodinotus grunniens</i>

Appendix C. Power Analyses for Fish

Appendix C contains six tables, one for each trend analysis area, listing statistical power (at $\alpha = 0.05$) to detect a 20% annual change in mean catch-per-unit-effort (CPUE) for fish species. Within each table, the fish listed first (*in boldface*) are the 14 species of special interest to Long Term Resource Monitoring Program partners (black crappie, bluegill, channel catfish, common carp, emerald shiner, freshwater drum, gizzard shad, largemouth bass, northern pike, sauger, smallmouth buffalo, walleye, white bass, and white crappie). The remaining species listed in each table are those for which power to detect a 20% change in mean CPUE was at least 0.50 for one or more sampling gears at doubled the present level of effort. All power values of 0.50 or greater are listed in bold type.

Table C-1. For Navigation Pool 4, statistical power (at $\alpha = 0.05$) to detect a 20% annual change in mean catch-per-unit-effort at halved, present, and doubled levels of effort with eight standard sampling gears used in the Long Term Resource Monitoring Program (LTRMP). Fish were sampled from 1993 to 1999. Fish species listed include the 14 species (*in bold*) of special interest to LTRMP partners and other species for which power was at least 0.50 (*in bold*) for one or more gears at the doubled level of effort. Blank spaces indicate an aquatic area category not sampled by that gear or low power. (Shaded bars are added for readability.)

Fish species	Aquatic area category*	Sampling gear and effort											
		Day electrofishing				Seine				Fyke net			
		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled	
Black crappie	BWCO	0.08	0.12	0.19									
	BWCS	0.30	0.53	0.84		0.62	0.93	0.99		0.42	0.76	0.95	
Bluegill	BWCS	0.52	0.81	0.98									
	MCBU	0.11	0.18	0.33									
Channel catfish	SCB	0.10	0.15	0.27									
	SCB	0.98	0.99	0.99									
Common carp	MCBU	0.52	0.83	0.99									
	BWCS	0.50	0.80	0.98		0.23	0.44	0.72		0.09	0.14	0.23	
Freshwater drum	SCB	0.27	0.51	0.82									
	BWCS	0.46	0.75	0.97		0.09	0.15	0.25		0.09	0.14	0.23	
Gizzard shad	MCBU	0.22	0.41	0.70						0.06	0.08	0.11	
	SCB	0.28	0.53	0.84						0.07	0.10	0.15	
Largemouth bass	BWCS	0.66	0.92	0.99		0.07	0.10	0.15		0.07	0.11	0.17	
	SCB	0.30	0.56	0.87						0.07	0.09	0.13	
Northern pike	BWCO	0.06	0.07	0.10									
	BWCS	0.16	0.28	0.51		0.19	0.34	0.60		0.07	0.09	0.13	
Sauger	MCBU	0.15	0.27	0.49						0.05	0.06	0.07	
	SCB	0.28	0.52	0.83						0.07	0.09	0.12	
Smallmouth buffalo	MCBU	0.72	0.96	0.99						<0.01	<0.01	<0.01	
	SCB	0.08	0.13	0.21						<0.01	<0.01	<0.01	
Walleye	MCBU	0.18	0.32	0.57						0.05	0.06	0.07	
	SCB	0.21	0.40	0.70						0.36	0.66	0.92	
White bass	MCBU	0.36	0.64	0.91						0.17	0.35	0.60	
	BWCS	0.08	0.11	0.17						0.05	0.06	0.07	
White crappie	MCBU	0.22	0.39	0.68						0.05	0.05	0.05	
	BWCS	0.07	0.09	0.13		0.09	0.14	0.22		0.09	0.13	0.23	
Bowfin	BWCO	0.07	0.09	0.13		0.09	0.14	0.22		0.07	0.10	0.15	
	MCBU	0.50	0.81	0.98		0.20	0.37	0.64		0.09	0.14	0.24	
Shorthead redhorse	BWCS	0.22	0.39	0.68									
	SCB	0.53	0.84	0.99									
Silver redhorse	BWCO	0.22	0.41	0.70						0.06	0.07	0.09	
	BWCS	0.35	0.61	0.90		0.35	0.63	0.90		0.06	0.07	0.08	
Smallmouth bass	MCBU	0.72	0.96	0.99						0.10	0.17	0.29	
	SCB	0.36	0.65	0.93						0.06	0.08	0.12	
Spotted sucker	BWCS	0.36	0.63	0.91		0.12	0.21	0.37		0.05	0.06	0.07	
	MCBU	0.18	0.31	0.56		<0.01	<0.01	<0.01		0.05	0.06	0.08	
Spottail shiner	BWCS	0.11	0.19	0.33									
	MCBU	0.54	0.83	0.99		0.14	0.25	0.45		0.07	0.09	0.13	
Yellow perch	BWCS	0.11	0.19	0.33									
	MCBU	0.54	0.83	0.99		0.14	0.25	0.45		0.07	0.09	0.13	

*BWCO = Backwater contiguous lake offshore, BWCS = Backwater contiguous lake shoreline, MCBU = Main channel border unstructured, SCB = Side channel border.

Table C-2. For Navigation Pool 8, statistical power (at $\alpha = 0.05$) to detect a 20% annual change in mean catch-per-unit-effort at halved, present, and doubled levels of effort with eight standard sampling gears used in the Long Term Resource Monitoring Program (LTRMP). Fish were sampled from 1993 to 1999. Fish species listed include the 14 species (*in bold*) of special interest to LTRMP partners and other species for which power was at least 0.50 (*in bold*) for one or more gears at the doubled level of effort. Blank spaces indicate an aquatic area category not sampled by that gear or low power. (Shaded bars are added for readability.)

Fish species	Aquatic area category ^a	Sampling gear and effort											
		Day electrofishing			Seine			Fyke net			Mini fyke net		
		Halved	Present	Doubled	Halved	Present	Doubled	Halved	Present	Doubled	Halved	Present	Doubled
Black crappie	BWCO	0.33	0.60	0.88	0.11	0.19	0.36	0.99	0.99	0.99	0.27	0.49	0.78
Bluegill	BWCS	0.77	0.97	0.99	0.26	0.51	0.85	0.94	0.99	0.99	0.49	0.80	0.98
Channel catfish	MCBU	0.07	0.10	0.15	0.05	0.05	0.05	0.99	0.99	0.99	0.06	0.06	0.08
	SCB	0.09	0.14	0.24	<0.01	<0.01	<0.01	0.99	0.99	0.99	<0.01	<0.01	<0.01
Common carp	SCB	0.88	0.99	0.99	0.06	0.07	0.10	0.99	0.99	0.99	0.08	0.11	0.17
Emerald shiner	MCBU	0.40	0.72	0.95	0.52	0.86	0.99	0.99	0.99	0.99	0.15	0.25	0.48
Freshwater drum	BWCS	0.38	0.67	0.93	0.09	0.15	0.28	0.29	0.52	0.82	0.11	0.18	0.30
	SCB	0.19	0.34	0.61	0.10	0.16	0.28	0.99	0.99	0.99	0.08	0.11	0.17
Gizzard shad	BWCS	0.36	0.64	0.91	0.08	0.13	0.23	0.14	0.22	0.40	0.12	0.20	0.35
	MCBU	0.10	0.17	0.29	0.07	0.10	0.15	0.99	0.99	0.99	0.07	0.08	0.12
	SCB	0.29	0.54	0.84	0.11	0.18	0.32	0.99	0.99	0.99	0.07	0.10	0.14
Largemouth bass	BWCS	0.71	0.95	0.99	0.13	0.24	0.47	0.14	0.23	0.41	0.10	0.16	0.21
	SCB	0.51	0.82	0.99	0.09	0.12	0.21	0.99	0.99	0.99	0.06	0.08	0.11
Northern pike	BWCO	0.20	0.36	0.63	0.09	0.13	0.24	0.31	0.54	0.84	0.07	0.10	0.16
Sauger	MCBU	0.13	0.23	0.43	0.07	0.10	0.16	0.99	0.99	0.99	0.08	0.11	0.18
	SCB	0.34	0.61	0.89	0.07	0.09	0.14	0.99	0.99	0.99	0.06	0.07	0.09
Smallmouth buffalo	MCBU	0.07	0.10	0.16	0.06	0.07	0.10	0.99	0.99	0.99	0.05	0.06	0.07
	SCB	0.10	0.16	0.28	0.05	0.06	0.06	0.99	0.99	0.99	0.05	0.05	0.06
Walleye	MCBU	0.08	0.11	0.19	0.07	0.11	0.17	0.99	0.99	0.99	0.06	0.07	0.10
	SCB	0.13	0.22	0.39	0.06	0.07	0.10	0.99	0.99	0.99	0.06	0.08	0.10
White bass	MCBU	0.31	0.59	0.88	0.20	0.39	0.66	0.99	0.99	0.99	0.13	0.22	0.41
White crappie	BWCS	0.07	0.10	0.15	0.06	0.07	0.10	0.19	0.34	0.59	0.07	0.09	0.13
Bowfin	BWCS	0.19	0.35	0.62	0.05	0.05	0.05	0.47	0.76	0.97	0.06	0.06	0.10
Bullhead minnow	MCBU	0.21	0.39	0.68	0.33	0.63	0.90	0.99	0.99	0.99	0.33	0.60	0.88
	SCB	0.51	0.82	0.98	0.38	0.66	0.93	0.99	0.99	0.99	0.10	0.15	0.27
Channel shiner	MCBU	0.12	0.21	0.38	0.21	0.41	0.69	0.99	0.99	0.99	0.10	0.15	0.27
Golden redhorse	SCB	0.44	0.75	0.96	0.06	0.06	0.07	0.99	0.99	0.99	<0.01	<0.01	<0.01
Johnny darter	MCBU	0.23	0.44	0.74	<0.01	<0.01	<0.01	0.99	0.99	0.99	0.17	0.30	0.53
	BWCS	0.26	0.47	0.77	0.16	0.30	0.58	<0.01	<0.01	<0.01	0.99	0.99	0.99
	SCB	0.26	0.47	0.77	0.15	0.27	0.50	0.99	0.99	0.99	0.15	0.27	0.47
Logperch	BWCS	0.24	0.43	0.73	0.09	0.14	0.25	<0.01	<0.01	<0.01	0.99	0.99	0.99
	MCBU	0.25	0.47	0.78	0.17	0.32	0.56	0.99	0.99	0.99	0.11	0.17	0.31
Longnose gar	BWCS	0.07	0.10	0.14	0.05	0.06	0.07	0.23	0.51	0.70	0.08	0.12	0.19
Orange-spotted sunfish	BWCS	0.23	0.43	0.72	0.06	0.08	0.11	0.99	0.99	0.99	0.12	0.19	0.34
Pumpkinseed	BWCS	0.24	0.45	0.74	0.16	0.31	0.59	0.99	0.99	0.99	0.27	0.50	0.78
River shiner	BWCS	0.14	0.25	0.45	0.05	0.05	0.05	0.17	0.28	0.51	0.12	0.19	0.33
	MCBU	0.33	0.61	0.90	0.48	0.82	0.98	0.99	0.99	0.99	0.12	0.19	0.37
	SCB	0.28	0.52	0.82	0.23	0.41	0.71	0.99	0.99	0.99	0.09	0.13	0.22
Rock bass	BWCS	0.27	0.50	0.80	0.10	0.17	0.33	0.19	0.33	0.58	0.11	0.18	0.32
	MCBU	0.41	0.71	0.95	0.08	0.12	0.21	0.99	0.99	0.99	0.10	0.16	0.27
Shorthead redhorse	MCBU	0.41	0.72	0.96	0.07	0.11	0.17	0.99	0.99	0.99	0.10	0.15	0.28
	SCB	0.78	0.98	0.99	0.08	0.12	0.20	0.99	0.99	0.99	0.08	0.12	0.20
Shorthead gar	BWCS	0.08	0.12	0.20	0.05	0.06	0.06	0.59	0.87	0.99	0.15	0.25	0.45
Silver redhorse	MCBU	0.33	0.61	0.90	0.08	0.11	0.18	0.99	0.99	0.99	0.06	0.08	0.11
	SCB	0.75	0.97	0.99	0.08	0.12	0.20	0.99	0.99	0.99	0.06	0.08	0.11
Smallmouth bass	MCBU	0.66	0.94	0.99	0.13	0.23	0.41	0.99	0.99	0.99	0.06	0.06	0.08
	SCB	0.54	0.84	0.99	0.08	0.12	0.20	0.99	0.99	0.99	0.08	0.11	0.16
Spotfin shiner	SCB	0.73	0.96	0.99	0.42	0.71	0.96	0.99	0.99	0.99	0.34	0.62	0.89
Spotted sucker	MCBU	0.49	0.82	0.99	0.52	0.86	0.99	0.99	0.99	0.99	0.21	0.37	0.68
	BWCS	0.44	0.74	0.96	0.06	0.08	0.13	0.18	0.32	0.56	0.06	0.07	0.10
Yellow perch	BWCO	0.39	0.69	0.94	0.08	0.12	0.21	0.28	0.49	0.79	0.10	0.15	0.26
	BWCS	0.39	0.69	0.94	0.08	0.12	0.21	0.28	0.49	0.79	0.10	0.15	0.26

^aBWCO = Backwater contiguous lake offshore, BWCS = Backwater contiguous lake shoreline, MCBU = Main channel border unstructured, SCB = Side channel border.

Table C-4. For Navigation Pool 26, statistical power (at $\alpha = 0.05$) to detect a 20% annual change in mean catch-per-unit-effort at halved, present, and doubled levels of effort with eight standard sampling gears used in the Long Term Resource Monitoring Program (LTRMP). Fish were sampled from 1993 to 1999. Fish species listed include the 14 species (*in bold*) of special interest to LTRMP partners and other species for which power was at least 0.50 (*in bold*) for one or more gears at the doubled level of effort. Blank spaces indicate an aquatic area category not sampled by that gear or low power. (Shaded bars are added for readability.)

Fish species	Aquatic area category	Sampling gear and effort											
		Day electrofishing				Seine				Fyke net			
		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled	
Black crappie	BWCS	0.15	0.28	0.49		0.36	0.73	0.96		0.10	0.17	0.32	
	IMPS	0.09	0.13	0.23		0.26	0.58	0.87		0.09	0.17	0.31	
Bluegill	BWCS	0.54	0.88	0.99		0.39	0.76	0.97		0.14	0.25	0.47	
	IMPS	0.63	0.90	0.99		0.14	0.29	0.51		0.17	0.38	0.70	
Channel catfish	MCBU	0.58	0.87	0.99						0.09	0.16	0.27	
	SCB	0.50	0.80	0.98		0.06	0.08	0.12		0.13	0.21	0.38	
Common carp	SCB	0.99	0.99	0.99		0.06	0.08	0.11		0.08	0.11	0.17	
	MCBU	0.31	0.54	0.85		<0.01	<0.01	<0.01		0.11	0.22	0.38	
Emerald shiner	SCB	0.54	0.83	0.99		0.13	0.25	0.46		0.09	0.15	0.26	
	BWCS	0.65	0.94	0.99		0.11	0.19	0.36		0.14	0.24	0.44	
Freshwater drum	SCB	0.64	0.91	0.99		0.20	0.43	0.73		0.17	0.34	0.61	
	BWCS	0.93	0.99	0.99		0.07	0.08	0.13		0.07	0.11	0.18	
Gizzard shad	MCBU	0.88	0.99	0.99		0.07	0.08	0.13		0.05	0.05	0.06	
	SCB	0.83	0.98	0.99		0.06	0.09	0.13		0.06	0.07	0.10	
Largemouth bass	BWCS	0.11	0.20	0.35		0.06	0.08	0.10		0.06	0.07	0.10	
	IMPS	0.65	0.92	0.99		0.05	0.05	0.06		0.06	0.07	0.09	
Northern pike	SCB	0.11	0.17	0.31		0.05	0.05	0.06		0.06	0.07	0.09	
	IMPS	<0.01	<0.01	<0.01		0.05	0.05	0.06		0.05	0.05	0.06	
Sauger	MCBU	0.14	0.23	0.42		0.06	0.08	0.11		0.06	0.07	0.09	
	SCB	0.13	0.21	0.38		0.06	0.08	0.10		0.07	0.10	0.17	
Smallmouth buffalo	IMPS	0.21	0.37	0.66		0.06	0.07	0.10		0.06	0.07	0.09	
	MCBU	0.41	0.68	0.94		0.05	0.05	0.06		0.05	0.06	0.06	
Walleye	SCB	0.29	0.52	0.82		0.05	0.05	0.06		0.05	0.06	0.06	
	MCBU	0.05	0.05	0.06		0.06	0.08	0.11		0.06	0.07	0.09	
White bass	SCB	0.77	0.97	0.99		0.06	0.07	0.10		0.06	0.07	0.09	
	IMPS	0.12	0.22	0.39		0.22	0.46	0.77		0.10	0.17	0.30	
White crappie	BWCS	0.12	0.22	0.39		0.06	0.08	0.12		0.06	0.07	0.09	
	IMPS	0.06	0.07	0.10		0.05	0.05	0.06		0.05	0.06	0.06	
Flathead catfish	MCBU	0.27	0.48	0.79		0.06	0.08	0.11		0.06	0.07	0.09	
	SCB	0.22	0.49	0.83		0.05	0.05	0.06		0.05	0.06	0.06	
Orangespotted sunfish	BWCS	0.38	0.70	0.94		0.06	0.08	0.12		0.19	0.38	0.68	
	IMPS	0.20	0.35	0.63		0.45	0.83	0.99		0.16	0.31	0.57	
Shorthead gar	BWCS	0.17	0.32	0.56		0.11	0.22	0.40		0.07	0.11	0.18	
	IMPS	0.12	0.20	0.36		0.08	0.12	0.21		0.08	0.12	0.19	
Shortnose gar	SCB	0.43	0.72	0.95		0.05	0.05	0.06		0.05	0.06	0.06	
	IMPS	0.12	0.20	0.36		0.08	0.12	0.21		0.08	0.12	0.19	

⁴BWCS = Backwater contiguous lake shoreline, IMPS = Backwater contiguous shoreline, MCBU = Main channel border unstructured, SCB = Side channel border.

Table C-5. For the Open River trend analysis area, statistical power (at $\alpha = 0.05$) to detect a 20% annual change in mean catch-per-unit-effort at halved, present, and doubled levels of effort with eight standard sampling gears used in the Long Term Resource Monitoring Program (LTRMP). Fish were sampled from 1993 to 1999. Fish species listed include the 14 species (*in bold*) of special interest to LTRMP partners and other species for which power was at least 0.50 (*in bold*) for one or more gears at the doubled level of effort. Blank spaces indicate an aquatic area category not sampled by that gear or low power. (Shaded bars are added for readability.)

Fish species	Aquatic area category ^a	Sampling gear and effort												Small hoop net				Tandem fyke net				Tandem mini fyke net																			
		Day electrofishing				Seine				Fyke net				Mini fyke net				Large hoop net				Small hoop net				Tandem fyke net				Tandem mini fyke net											
		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled	
Black crappie	MCBW	0.06	0.06	0.08		<0.01	<0.01	<0.01		<0.01	0.06	0.08		<0.01	0.09	0.14		0.24	0.05	0.06		0.06	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Bluegill	SCB	0.07	0.08	0.12		<0.01	<0.01	<0.01		0.07	0.11	0.17		0.10	0.15	0.26		0.26	0.06	0.06		0.07	0.06	0.06		0.06	0.06	0.08		0.06	0.06	0.07		0.06	0.06	0.07		0.06	0.06	0.08	
	SCB	0.10	0.17	0.29		<0.01	<0.01	<0.01		0.07	0.09	0.13		0.24	0.45	0.75		0.75	0.05	0.05		0.06	0.06	0.06		0.06	0.06	0.08		0.06	0.06	0.07		0.06	0.06	0.07		0.06	0.06	0.08	
Channel catfish	MCBU	0.32	0.62	0.91		<0.01	0.10	0.19		0.08	0.13	0.23		0.18	0.32	0.58		0.58	0.09	0.18		0.30	0.25	0.50		0.50	0.80		0.50	0.50	0.80		0.50	0.50	0.80		0.50	0.50	0.80		
Common carp	SCB	0.36	0.64	0.91		0.08	0.14	0.28		0.08	0.13	0.23		0.43	0.75	0.96		0.96	0.29	0.54		0.84	0.51	0.80		0.84	0.98		0.84	0.80	0.98		0.84	0.80	0.98		0.84	0.80	0.98		
	SCB	0.78	0.98	0.99		0.05	0.05	0.06		0.12	0.22	0.41		0.14	0.24	0.44		0.44	0.42	0.73		0.96	0.43	0.71		0.95			0.95	0.95			0.95	0.95			0.95	0.95			
Emerald shiner	MCBU	0.23	0.45	0.76		<0.01	0.23	0.53						0.13	0.22	0.40		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Freshwater drum	MCBU	0.17	0.33	0.60		<0.01	0.06	0.08		0.18	0.36	0.64		0.34	0.62	0.90		0.90	0.23	0.43		0.73	0.10	0.15		0.10	0.15	0.26		0.10	0.15	0.26		0.10	0.15	0.26		0.10	0.15	0.26	
Gizzard shad	SCB	0.29	0.53	0.82		0.06	0.08	0.13		0.08	0.11	0.18		0.16	0.28	0.51		0.51	0.07	0.10		0.14	0.06	0.06		0.06	0.06	0.08		0.06	0.06	0.07		0.06	0.06	0.07		0.06	0.06	0.08	
	MCBU	0.70	0.97	0.99		<0.01	0.54	0.93		0.08	0.11	0.18		0.16	0.28	0.51		0.51	0.07	0.10		0.14	0.06	0.06		0.06	0.06	0.08		0.06	0.06	0.07		0.06	0.06	0.07		0.06	0.06	0.08	
Largemouth bass	SCB	0.81	0.99	0.99		0.10	0.24	0.51		0.08	0.11	0.18		0.25	0.48	0.78		0.78	0.10	0.17		0.29	0.05	0.06		0.06	0.06	0.08		0.06	0.06	0.07		0.06	0.06	0.07		0.06	0.06	0.08	
	MCBW	0.06	0.08	0.11		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Northern pike	SCB	0.06	0.08	0.10		<0.01	<0.01	<0.01		0.05	0.05	0.06		0.05	0.05	0.06		0.06	0.06	0.06		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
	MCBU	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Sauger	MCBU	0.07	0.11	0.17		<0.01	0.05	0.06		0.06	0.07	0.08		0.08	0.11	0.17		0.17	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Smallmouth buffalo	SCB	0.08	0.12	0.19		0.05	0.06	0.07		0.06	0.07	0.08		0.08	0.11	0.18		0.18	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
	MCBU	0.14	0.29	0.52		<0.01	<0.01	<0.01		0.06	0.08	0.11		0.05	0.05	0.06		0.06	0.14	0.29		0.52	0.07	0.09		0.14	0.06	0.08		0.14	0.06	0.06		0.07	0.09	0.14		0.09	0.14	0.20	
Walleye	SCB	0.23	0.44	0.72		0.34	0.89	0.99		0.06	0.08	0.11		0.06	0.07	0.10		0.10	0.35	0.64		0.91	0.08	0.12		0.20	0.08	0.12		0.20	0.08	0.12		0.20	0.08	0.12		0.20	0.08	0.12	
	MCBU	0.05	0.06	0.07		<0.01	<0.01	<0.01		0.06	0.07	0.08		0.08	0.11	0.18		0.18	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
White bass	MCBU	0.33	0.63	0.92		<0.01	0.06	0.10		0.13	0.22	0.40		0.13	0.22	0.40		0.40	0.06	0.08		0.12	0.07	0.10		0.16	0.16	0.19		0.16	0.16	0.19		0.16	0.16	0.19		0.16	0.16	0.19	
	MCBU	0.52	0.84	0.99		0.06	0.07	0.11		0.10	0.18	0.32		0.15	0.26	0.47		0.47	0.08	0.11		0.17	0.08	0.12		0.08	0.12	0.19		0.08	0.12	0.19		0.08	0.12	0.19		0.08	0.12	0.19	
White crappie	SCB	0.06	0.08	0.10		<0.01	<0.01	<0.01		0.07	0.10	0.16		0.13	0.22	0.40		0.40	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
	MCBW	0.05	0.06	0.06		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		0.26	0.50	0.83		0.83	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Channel shiner	SCB	0.09	0.13	0.22		0.05	0.07	0.09		<0.01	<0.01	<0.01		0.20	0.37	0.65		0.65	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Flathead catfish	MCBW	0.24	0.50	0.81		0.05	0.05	0.06		<0.01	0.30	0.56		0.06	0.08	0.11		0.11	0.09	0.14		0.14	0.07	0.12		0.07	0.12	0.20		0.07	0.12	0.20		0.07	0.12	0.20		0.07	0.12	0.20	
	SCB	0.18	0.33	0.58		0.05	0.05	0.06		0.10	0.17	0.30		0.09	0.14	0.24		0.24	0.16	0.29		0.52	0.21	0.37		0.52	0.21	0.37		0.52	0.21	0.37		0.52	0.21	0.37		0.52	0.21	0.37	
Goldeye	MCBU	0.37	0.69	0.95		<0.01	0.08	0.14		0.06	0.06	0.08		0.08	0.10	0.17		0.17	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
	SCB	0.24	0.44	0.72		<0.01	<0.01	<0.01		0.06	0.06	0.08		0.10	0.16	0.28		0.28	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Red shiner	MCBW	0.09	0.15	0.26		0.06	0.09	0.16		<0.01	<0.01	<0.01		0.16	0.30	0.57		0.57	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
	SCB	0.35	0.63	0.90		0.06	0.09	0.16		<0.01	<0.01	<0.01		0.14	0.25	0.44		0.44	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
River carpsucker	SCB	0.28	0.52	0.81		0.08	0.14	0.28		0.08	0.12	0.19		0.08	0.12	0.20		0.20	0.15	0.26		0.47	0.07	0.09		0.47	0.07	0.09		0.47	0.07	0.09		0.47	0.07	0.09		0.47	0.07	0.09	
River shiner	MCBU	0.06	0.08	0.11		<0.01	<0.01	<0.01		0.07	0.08	0.12		0.07	0.08	0.12		0.12	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	
Shorthead ear	SCB	0.26	0.49	0.78		0.05	0.06	0.07		0.13	0.24	0.45		0.10	0.16	0.30		0.30	0.06	0.11		0.18	0.08	0.11		0.18	0.08	0.11		0.18	0.08	0.11		0.18	0.08	0.11		0.18	0.08	0.11	

*MCBW = Main channel border wing dam, MCBU = Main channel border unstructured, SCB = Side channel border.

Table C-6. For La Grange Pool, Illinois River, statistical power (at $\alpha = 0.05$) to detect a 20% annual change in mean catch-per-unit-effort at halved, present, and doubled levels of effort with eight standard sampling gears used in the Long Term Resource Monitoring Program (LTRMP). Fish were sampled from 1993 to 1999. Fish species listed include the 14 species (*in bold*) of special interest to LTRMP partners and other species for which power was at least 0.50 (*in bold*) for one or more gears at the doubled level of effort. Blank spaces indicate an aquatic area category not sampled by that gear or low power. (Shaded bars are added for readability.)

Fish species	Aquatic area category ^a	Sampling gear and effort															
		Day electrofishing				Seine				Fyke net				Mini fyke net			
		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled		Halved	Present	Doubled	
Black crappie	BWCO	0.64	0.92	0.99	0.06	0.07	0.09	0.09	0.99	0.87	0.99	0.99	0.73	0.24	0.44	0.73	
Bluegill	BWCS	0.89	0.99	0.99	0.06	0.07	0.10	0.10	0.99	0.74	0.96	0.99	0.97	0.47	0.78	0.97	
Channel catfish	MCBU	0.34	0.60	0.89	0.06	0.07	0.10			0.20	0.36	0.62	0.24	0.45	0.74	0.57	0.99
	SCB	0.64	0.92	0.99	0.06	0.07	0.10			0.20	0.37	0.65	0.20	0.36	0.65	0.26	0.81
Common carp	SCB	0.99	0.99	0.99	<0.01	<0.01	<0.01	<0.01		0.13	0.22	0.41	0.83	0.99	0.99	0.90	0.99
Emerald shiner	MCBU	0.39	0.67	0.93	0.45	0.82	0.99			0.33	0.59	0.87	<0.01	<0.01	<0.01	<0.01	<0.01
Freshwater drum	BWCS	0.66	0.93	0.99	<0.01	<0.01	<0.01			0.61	0.90	0.99	0.15	0.27	0.51	0.11	0.33
	SCB	0.75	0.97	0.99	0.06	0.07	0.10			0.38	0.67	0.93	0.32	0.58	0.86		
Gizzard shad	BWCS	0.99	0.99	0.99	0.23	0.52	0.85	0.99	0.99	0.59	0.89	0.99	0.11	0.18	0.33	0.05	0.06
	MCBU	0.85	0.99	0.99	0.32	0.65	0.93			0.23	0.43	0.71	0.10	0.15	0.28	0.05	0.06
	SCB	0.99	0.99	0.99	0.40	0.94	0.99			0.28	0.52	0.82	0.10	0.15	0.28	0.05	0.06
Largemouth bass	BWCS	0.96	0.99	0.99	0.11	0.22	0.42	0.15	0.26	0.46	0.46	0.46	<0.01	<0.01	<0.01	<0.01	<0.01
	SCB	0.46	0.77	0.97	0.06	0.10	0.18			0.12	0.20	0.36	<0.01	<0.01	<0.01	<0.01	<0.01
Northern pike	BWCO	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			0.05	0.05	0.06	<0.01	<0.01	<0.01	0.05	0.06
Sauger	BWCS	0.49	0.80	0.98	0.07	0.10	0.16			0.18	0.32	0.55	0.06	0.06	0.07	0.06	0.06
	SCB	0.35	0.62	0.89	0.07	0.11	0.19	0.10	0.16	0.12	0.19	0.34	0.06	0.06	0.07	0.05	0.06
Smallmouth buffalo	MCBU	0.72	0.95	0.99	0.12	0.23	0.44			0.10	0.16	0.27	0.60	0.90	0.99	0.09	0.14
	SCB	0.87	0.99	0.99	0.06	0.07	0.10			0.08	0.12	0.19	0.37	0.66	0.93	0.08	0.11
Walleye	MCBU	0.05	0.06	0.06	<0.01	<0.01	<0.01			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	SCB	0.06	0.07	0.09	<0.01	<0.01	<0.01			0.05	0.06	0.07	<0.01	<0.01	<0.01	<0.01	<0.01
White bass	MCBU	0.95	0.99	0.99	0.34	0.67	0.94			0.62	0.91	0.99	0.08	0.11	0.17	0.09	0.14
White crappie	BWCO	0.41	0.71	0.95	0.06	0.07	0.10	0.59	0.89	0.22	0.41	0.69	0.09	0.14	0.24	0.11	0.17
	BWCS	0.53	0.83	0.99	0.06	0.07	0.10	0.11	0.17	0.30	0.08	0.11	0.05	0.05	0.06	<0.01	<0.01
	SCB	0.38	0.66	0.92	<0.01	<0.01	<0.01			<0.01	<0.01	<0.01	0.05	0.05	0.06	<0.01	<0.01
Black buffalo	BWCS	0.20	0.37	0.63	<0.01	<0.01	<0.01	0.07	0.09	0.13	<0.01	<0.01					
Brown bullhead	BWCS	0.08	0.12	0.19	<0.01	<0.01	<0.01	0.19	0.33	0.58	0.08	0.10	0.09	0.14	0.25	0.07	0.09
Flathead catfish	SCB	0.19	0.33	0.58	<0.01	<0.01	<0.01			0.06	0.07	0.10	0.09	0.14	0.25	0.07	0.09
River carp sucker	BWCS	0.26	0.47	0.77	0.09	0.15	0.28	0.37	0.66	0.92	0.07	0.10	0.09	0.15	0.26	0.05	0.06
	SCB	0.21	0.37	0.64	0.09	0.19	0.40			0.07	0.09	0.14	0.09	0.15	0.26	0.05	0.06
Shortnose gar	BWCS	0.13	0.22	0.38	<0.01	<0.01	<0.01	0.40	0.69	0.94	0.15	0.26	<0.01	<0.01	<0.01	<0.01	<0.01
Skipjack herring	MCBU	0.30	0.55	0.84	0.06	0.07	0.10			0.06	0.07	0.10	<0.01	<0.01	<0.01	<0.01	<0.01
Silver chub	SCB	0.08	0.10	0.16	0.16	0.47	0.84			0.08	0.10	0.16	<0.01	<0.01	<0.01	<0.01	<0.01
Spottail shiner	MCBU	0.05	0.06	0.06	0.29	0.60	0.90			0.07	0.10	0.15	<0.01	<0.01	<0.01	<0.01	<0.01
Threadfin shiner	MCBU	0.23	0.42	0.71	0.09	0.15	0.26			0.09	0.13	0.22	<0.01	<0.01	<0.01	<0.01	<0.01
Yellow bullhead	BWCS	0.11	0.17	0.29	<0.01	<0.01	<0.01	0.19	0.34	0.60	0.12	0.19	0.09	0.13	0.22	<0.01	<0.01

^aBWCO = Backwater contiguous lake offshore, BWCS = Backwater contiguous lake shoreline, MCBU = Main channel border unstructured, SCB = Side channel border.

Appendix D. Catch by Gear Type for Fish of All Sizes

Appendix D contains six tables, one for each trend analysis area, listing mean annual catch and variance of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program and the percentage of total annual catch accounted for by that species within each gear and across all gears. Fish of all sizes were included in these analyses. Information on how each gear is fished and what constitutes an independent sample can be found in Gutreuter et al. (1995.)

Table D-1. For Navigation Pool 4, mean annual catch for fish of all sizes and variance (in parentheses) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (in parentheses). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within Navigation Pool 4 are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

	Day electrofishing N = 81.3 (1.8)				Night electrofishing N = 11.7 (0.2)				Bottom trawling N = 4.0 (0.8)				Sailing N = 30.4 (2.2)				Mini fyke nets N = 61.1 (2.5)				Fyke nets N = 32.3 (1.9)				Large hoop nets N = 55.4 (3.1)				Small hoop nets N = 55.4 (3.3)				Tandem fyke nets N = 26.6 (1.3)				Tandem mini fyke nets N = 26.6 (1.2)				All gases combined N = 364.7 (8.8)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch	Mean annual catch (variance)	This All gear	Mean annual catch (variance)	Percentage of annual catch																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Species	4030 (1088)	46	8	4951 (2518)	65	10	<1	<1	8713 (2904)	72	17	34116 (18016)	94	66	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<

Table D-2. For Navigation Pool 8, mean annual catch for fish of all sizes and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within Navigation Pool 8 are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

[illegible]

Table D-3. For Navigation Pool 13, mean annual catch for fish of all sizes and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within Navigation Pool 13 are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

Species	Day electrofishing N = 60.1 (1.5)			Night electrofishing N = 21.6 (1.4)			Bottom trawling N = 5.4 (0.4)			Seining N = 52.0 (2.0)			Mini fyke nets N = 71.4 (2.8)			Fyke nets N = 51.6 (0.4)			Large hoop nets N = 51.0 (2.0)			Small hoop nets N = 51.3 (2.0)			Tandem fyke nets N = 20.3 (0.3)			Tandem mini fyke nets N = 20.7 (0.3)			All gears combined N = 385.7 (13.0)		
	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)	Mean annual catch (variance)	This All gears	Percentage of annual catch (variance)			
Emerald shiner	876 (188)	16	9	1050 (646)	21	11	<1 (<1)	<1	6209 (1758)	32	64	15	14	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	9058 (2438)	21	
Bluegill	1011 (225)	18	15	507 (94)	10	8	<1 (<1)	<1	1441 (439)	7	22	1275 (582)	25	34	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	6652 (976)	14		
River shiner	131 (25)	2	2	80 (33)	2	1	<1 (<1)	<1	4492 (809)	23	82	757 (321)	8	24	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	5472 (998)	12		
Freshwater drum	125 (23)	2	3	540 (144)	11	13	26 (11)	19	755 (702)	4	18	1020 (845)	11	24	57 (18)	3	1	87 (27)	13	2	45 (20)	14	1	161 (65)	10	4	1377 (1210)	49	33	4192 (2970)	9		
Channel shiner	41 (19)	1	1	75 (42)	2	2	<1 (<1)	<1	2034 (1508)	10	59	1178 (787)	13	34	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	3420 (2470)	7		
Gizzard shad	1409 (697)	25	43	549 (220)	11	17	<1 (<1)	<1	556 (163)	3	17	340 (199)	4	10	186 (78)	10	6	5 (3)	1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	3279 (1074)	7			
Largemouth bass	348 (51)	6	25	163 (27)	3	12	<1 (<1)	<1	534 (391)	3	39	279 (180)	3	20	31 (4)	2	2	2 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	1374 (478)	3			
White bass	96 (27)	2	8	461 (131)	9	38	<1 (<1)	<1	104 (24)	<1	9	256 (85)	3	21	87 (27)	5	7	11 (3)	2	1	7 (4)	2	1	166 (57)	11	14	21 (10)	1	2	1208 (227)	3		
Common carp	548 (62)	10	46	185 (25)	4	16	<1 (<1)	<1	94 (43)	<1	8	150 (54)	2	13	55 (11)	3	5	27 (11)	4	2	18 (9)	5	1	31 (8)	2	3	74 (37)	3	6	1182 (173)	3		
Bullhead minnow	77 (21)	1	7	48 (20)	1	4	<1 (<1)	<1	717 (190)	4	64	170 (57)	2	15	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	1123 (190)	2		
Black crappie	66 (13)	1	6	37 (4)	1	3	<1 (<1)	<1	106 (84)	1	10	50 (13)	1	5	414 (78)	23	39	34 (11)	5	3	12 (5)	4	1	300 (99)	19	28	51 (27)	2	5	1070 (171)	2		
Orange-spotted sunfish	121 (36)	2	14	96 (31)	2	11	<1 (<1)	<1	243 (64)	1	29	262 (100)	3	31	7 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	843 (220)	2		
Mimic shiner	29 (29)	1	4	36 (36)	1	4	<1 (<1)	<1	516 (516)	3	64	216 (216)	2	27	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	805 (805)	2		
River carpucker	36 (14)	1	5	69 (33)	1	9	<1 (<1)	<1	419 (203)	2	55	190 (110)	2	25	26 (9)	1	3	9 (4)	1	1	1 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	760 (345)	2		
Smallmouth buffalo	38 (7)	1	7	74 (36)	2	13	<1 (<1)	<1	373 (146)	2	82	33 (16)	<1	7	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	577 (129)	1		
Brook silverside	18 (8)	<1	4	28 (13)	1	6	<1 (<1)	<1	382 (144)	<1	3	16 (4)	<1	7	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	452 (169)	1		
Pumpkinseed	62 (19)	1	14	17 (4)	<1	4	<1 (<1)	<1	34 (14)	<1	2	102 (60)	1	23	115 (31)	6	26	1 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	378 (52)	1			
Sauger	53 (8)	1	14	292 (42)	6	78	1 (1)	<1	292 (42)	<1	1	4 (1)	<1	<1	6 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	360 (51)	1		
Channel catfish	28 (4)	<1	8	25 (4)	<1	7	40 (21)	30	11	29 (12)	<1	20 (6)	<1	6	8 (2)	<1	25 (11)	4	7	169 (49)	52	47	4 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	358 (50)	1		
White crappie	55 (8)	1	15	17 (5)	<1	5	<1 (<1)	<1	45 (32)	<1	13	42 (9)	<1	12	84 (9)	5	23	12 (5)	2	3	3 (1)	1	73 (17)	5	20	2 (1)	<1	<1 (<1)	315 (54)	1			
Spottail shiner	57 (10)	1	18	8 (2)	<1	3	<1 (<1)	<1	186 (45)	1	59	63 (16)	1	20	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	265 (29)	1		
Shorthead redbone	71 (19)	1	27	120 (25)	2	45	1 (<1)	<1	18 (8)	<1	7	10 (3)	<1	4	12 (1)	1	4	9 (1)	1	4	3 (1)	1	1	19 (3)	1	7	2 (1)	<1	<1 (<1)	226 (105)	<1		
Spottail shiner	18 (4)	<1	8	5 (2)	<1	2	<1 (<1)	<1	139 (109)	1	61	49 (18)	1	21	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	194 (81)	<1		
Johnny darter	4 (1)	<1	2	2 (1)	<1	1	<1 (<1)	<1	145 (64)	1	75	39 (16)	<1	20	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	224 (81)	<1		
Walleye	31 (6)	1	17	128 (25)	3	69	<1 (<1)	<1	7 (2)	<1	4	5 (1)	<1	3	4 (1)	<1	2	1 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	184 (35)	<1			
Silver chub	23 (8)	<1	13	54 (9)	1	30	6 (4)	5	72 (26)	<1	40	15 (7)	<1	8	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	180 (47)	<1		
Golden shiner	40 (13)	1	24	14 (6)	<1	8	<1 (<1)	<1	19 (7)	<1	11	52 (18)	1	32	10 (2)	1	6	1 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	165 (35)	<1			
Shorthead gar	7 (1)	<1	4	7 (1)	<1	4	<1 (<1)	<1	6 (2)	<1	4	32 (5)	<1	20	77 (13)	4	48	1 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	162 (12)	<1			
River darter	1 (1)	<1	1	1 (<1)	<1	1	<1 (<1)	<1	32 (14)	<1	25	86 (45)	1	67	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	129 (62)	<1		
Logperch	30 (7)	1	28	15 (5)	<1	13	<1 (<1)	<1	32 (9)	<1	29	22 (10)	<1	20	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	109 (21)	<1		
Pumpkinseed	2 (1)	<1	2	1 (1)	<1	1	<1 (<1)	<1	14 (3)	<1	13	23 (4)	<1	22	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	107 (57)	<1		
Pumpkinseed	2 (1)	<1	2	1 (1)	<1	1	<1 (<1)	<1	46 (17)	<1	47	40 (18)	<1	42	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	97 (24)	<1		
Tadpole muddog	26 (4)	<1	32	8 (2)	<1	10	<1 (<1)	<1	1 (<1)	<1	1	1 (1)	<1	1	19 (4)	1	24	2 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	81 (7)	<1			
Spotted sucker	10 (3)	<1	14	7 (5)	<1	10	<1 (<1)	<1	14 (10)	<1	18	1 (1)	<1	2	10 (3)	1	13	1 (1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	75 (20)	<1			
Yellow perch	3 (1)	<1	4	1 (1)	<1	2	<1 (<1)	<1	32 (21)	<1	49	25 (13)	<1	39	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)	<1	<1 (<1)								

Table D-5. For Open River, mean annual catch for fish of all sizes and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). *N is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within Open River are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

Species	Day electrofishing N = 43.7 (5.1)			Night electrofishing N = 0			Bottom trawling N = 16.5 (8.1)			Seining N = 6.8 (1.2)			Mini fyke nets N = 80.1 (4.8)			Fyke nets N = 19.3 (1.2)			Large hoop nets N = 51.1 (6.1)			Small hoop nets N = 52.1 (6.3)			Tandem fyke nets N = 0			Tandem mini fyke nets N = 0			All gears combined N = 247.0 (27.9)		
	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear
Gizzard shad	4090 (863)	68	75	-	-	-	1 (1)	<1	<1	282 (88)	48	5	898 (406)	12	17	194 (177)	10	4	10 (4)	1	<1	1 (1)	<1	<1	-	-	-	-	-	5436 (1180)	31	<1	
Freshwater drum	162 (20)	3	3	-	-	-	87 (40)	44	2	9 (4)	1	<1	4233 (1419)	57	91	100 (23)	5	2	63 (18)	7	1	10 (2)	2	<1	-	-	-	-	-	4740 (1451)	27	<1	
Black crappie	13 (2)	<1	1	-	-	-	<1	<1	<1	<1	<1	65 (27)	1	6	1020 (981)	55	92	1 (1)	<1	<1	9 (7)	1	1	-	-	-	-	-	-	1107 (1003)	6	<1	
Common carp	255 (54)	4	26	-	-	-	1 (1)	<1	<1	<1	<1	71 (33)	1	7	33 (8)	2	3	396 (179)	43	40	224 (105)	37	23	-	-	-	-	-	-	980 (304)	6	<1	
Channel shiner	35 (18)	1	5	-	-	-	20 (19)	10	3	22 (15)	4	3	627 (325)	8	90	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	697 (352)	4	<1		
Channel catfish	94 (18)	2	14	-	-	-	55 (27)	28	8	18 (5)	3	3	146 (39)	2	21	9 (3)	<1	1	94 (32)	10	14	278 (62)	46	41	-	-	-	-	-	682 (104)	4	<1	
Emerald shiner	177 (62)	3	30	-	-	-	<1	<1	<1	132 (72)	22	22	297 (133)	4	51	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	586 (226)	3	<1		
White bass	125 (22)	2	25	-	-	-	1 (1)	<1	<1	11 (4)	2	2	114 (35)	2	22	245 (189)	13	48	7 (2)	1	9 (7)	2	2	-	-	-	-	-	-	510 (200)	3	<1	
Bluegill	93 (17)	2	21	-	-	-	<1	<1	<1	<1	<1	<1	302 (126)	4	68	32 (16)	2	7	1 (1)	<1	<1	<1	<1	-	-	-	-	-	444 (165)	3	<1		
Red shiner	173 (66)	3	50	-	-	-	<1	<1	<1	26 (14)	4	7	148 (69)	2	43	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	343 (104)	2	<1		
Goldeye	253 (124)	4	88	-	-	-	<1	<1	<1	5 (3)	1	2	26 (12)	<1	9	5 (4)	<1	2	<1	<1	<1	<1	<1	-	-	-	-	-	288 (137)	2	<1		
Smallmouth buffalo	63 (11)	1	25	-	-	-	<1	<1	<1	1 (1)	<1	<1	1 (1)	<1	11 (9)	1	4	169 (42)	18	66	11 (2)	2	4	-	-	-	-	-	256 (36)	1	<1		
River carp sucker	35 (7)	1	18	-	-	-	<1	<1	<1	16 (10)	3	8	50 (43)	1	26	15 (1)	1	8	73 (31)	8	39	4 (1)	1	2	-	-	-	-	-	190 (56)	1	<1	
White crappie	30 (12)	<1	17	-	-	-	<1	<1	<1	<1	<1	<1	84 (32)	1	46	61 (32)	3	34	4 (2)	<1	2	<1	<1	-	-	-	-	-	182 (46)	1	<1		
Shornose gar	58 (13)	1	39	-	-	-	<1	<1	<1	2 (1)	<1	1	22 (5)	<1	15	61 (21)	3	4	3 (1)	<1	2	3 (1)	1	2	-	-	-	-	-	148 (32)	1	<1	
Silverband shiner	16 (5)	<1	13	-	-	-	1 (1)	1	1	6 (2)	1	5	102 (37)	1	83	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	123 (43)	1	<1		
Flathead catfish	45 (8)	1	40	-	-	-	1 (1)	1	1	<1	<1	<1	8 (2)	<1	7	11 (3)	1	10	29 (7)	3	26	18 (7)	3	16	-	-	-	-	-	112 (21)	1	<1	
Black buffalo	10 (2)	<1	15	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1	3	49 (11)	5	71	8 (2)	1	1	-	-	-	-	69 (13)	<1	<1		
River shiner	17 (11)	<1	25	-	-	-	<1	<1	<1	37 (17)	6	54	19 (8)	<1	28	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	67 (19)	<1	<1		
Orangespotted sunfish	26 (13)	<1	49	-	-	-	<1	<1	<1	<1	<1	<1	26 (10)	<1	47	2 (2)	<1	4	<1	<1	<1	<1	<1	-	-	-	-	-	54 (22)	<1	<1		
Bignmouth buffalo	27 (10)	<1	51	-	-	-	<1	<1	<1	<1	<1	<1	19 (18)	<1	36	2 (2)	<1	5	4 (1)	<1	8	<1	<1	-	-	-	-	-	53 (19)	<1	<1		
Miss. silvery minnow	5 (3)	<1	11	-	-	-	<1	<1	<1	13 (6)	2	28	31 (25)	<1	66	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	47 (29)	<1	<1		
Spotted bass	37 (15)	1	93	-	-	-	<1	<1	<1	<1	<1	<1	3 (1)	<1	7	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	40 (16)	<1	<1		
Blue catfish	8 (3)	<1	20	-	-	-	11 (5)	6	30	1 (1)	<1	2	3 (1)	<1	8	1	<1	2	5 (1)	1	13	11 (5)	2	30	-	-	-	-	-	40 (8)	<1	<1	
Brook silverside	30 (17)	1	90	-	-	-	<1	<1	<1	1 (1)	<1	1	3 (1)	<1	8	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	34 (17)	<1	<1		
Green sunfish	19 (12)	<1	59	-	-	-	<1	<1	<1	<1	<1	<1	7 (2)	<1	23	6 (6)	<1	18	<1	<1	<1	<1	<1	-	-	-	-	-	32 (19)	<1	<1		
Threadfin shad	17 (9)	<1	57	-	-	-	<1	<1	<1	<1	<1	<1	12 (10)	<1	40	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	30 (19)	<1	<1		
Western mosquitofish	12 (8)	<1	42	-	-	-	<1	<1	<1	<1	<1	<1	16 (4)	<1	57	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	28 (11)	<1	<1		
Sauger	10 (3)	<1	40	-	-	-	<1	<1	<1	2 (1)	<1	7	10 (4)	<1	41	3 (1)	<1	10	<1	<1	<1	<1	<1	<1	-	-	-	-	-	25 (5)	<1	<1	
Silver chub	6 (2)	<1	28	-	-	-	1 (1)	<1	<1	2 (1)	<1	9	15 (4)	<1	63	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	23 (5)	<1	<1		
Largemouth bass	18 (5)	<1	83	-	-	-	<1	<1	<1	<1	<1	<1	1 (1)	<1	3	3 (3)	<1	14	<1	<1	<1	<1	<1	-	-	-	-	-	22 (6)	<1	<1		
Skipjack herring	12 (5)	<1	57	-	-	-	<1	<1	<1	4 (2)	1	17	5 (2)	<1	26	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	21 (7)	<1	<1		
Yellow bass	1 (1)	<1	4	-	-	-	<1	<1	<1	<1	<1	<1	1 (1)	<1	4	18 (13)	1	91	<1	<1	<1	<1	<1	-	-	-	-	-	20 (13)	<1	<1		
Bullhead minnow	2 (1)	<1	16	-	-	-	<1	<1	<1	<1	<1	<1	13 (5)	<1	84	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	15 (5)	<1	<1		
Warmouth	6 (4)	<1	42	-	-	-	<1	<1	<1	<1	<1	<1	9 (3)	<1	58	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	15 (5)	<1	<1		
Longnose gar	6 (1)	<1	46	-	-	-	<1	<1	<1	<1	<1	<1	5 (2)	<1	41	1 (1)	<1	8	<1	<1	<1	<1	<1	-	-	-	-	-	13 (3)	<1	<1		
Bighorn carp	1 (1)	<1	5	-	-	-	<1	<1	<1	1 (1)	<1	6	8 (4)	<1	74	<1	<1	3	1	<1	<1	<1	<1	-	-	-	-	-	11 (5)	<1	<1		
Shovelnose sturgeon	<1	<1	3	-	-	-	10 (4)	5	91	<1	<1	<1	1 (1)	<1	6	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	10 (4)	<1	<1		
Blue sucker	4 (2)	<1	54	-	-	-	<1	<1	<1	<1	<1	<1	3 (2)	<1	41	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	7 (3)	<1	<1		
Grass carp	<1	<1	18	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	14	<1	<1	6	<1	<1	<1	<1	<1	-	-	-	-	-	2 (1)	<1	<1		
Paddlefish	<1	<1	<1	-	-	-	1 (1)	<1	73	<1	<1	<1	<1	<1	<1	13	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	1 (1)	<1	<1		
Walleye	1 (1)	<1	80	-	-	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	20	<1	<1	<1	<1	<1	-	-	-	-	-	1 (1)	<1	<1		
Lake sturgeon	0 (0)	0	0	-	-	-	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	-	-	-	-	-	0 (0)	0	<1	
Northern pike	0 (0)	0	0	-	-	-	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	-	-	-	-	-	0 (0)	0	<1	
Silver carp	0 (0)	0	0	-	-	-	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	-	-	-	-	-	0 (0)	0	<1	
All species	6042 (983)	100	34	-	-	-	198 (99)	100	1	590 (121)	100	3	7548 (1608)	100	43	1852 (1433)	100	10	917 (224)	100	5	607 (166)	10										

Table D-6. For La Grange Pool, mean annual catch for fish of all sizes and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within La Grange Pool are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

Species	Day electrofishing N = 107.7 (10.8)			Night electrofishing N = 27.3 (7.8)			Bottom trawling N = 11.4 (0.3)			Seining N = 44.3 (2.3)			Mini fyke nets N = 82.7 (4.7)			Fyke nets N = 36.5 (3.4)			Large hoop nets N = 51.6 (2.2)			Small hoop nets N = 92.3 (2.6)			Tandem fyke nets N = 14.6 (1.2)			Tandem mini fyke nets N = 14.6 (1.2)			All gears combined N = 463.0 (19.4)		
	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear	Mean annual catch (variance)	This gear	All gear
19039 (6253)	67	42	2361 (551)	43	5	7 (7)	6	<1	4297 (1729)	61	9	18167 (8254)	61	40	375 (64)	7	1	56 (23)	3	<1	5 (3)	<1	<1	616 (92)	30	1	689 (307)	43	2	45612 (15178)	55		
Gizzard shad	696 (194)	2	91 (29)	2	1	<1 (<1)	<1	<1	1042 (230)	15	14	5654 (1759)	19	75	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	55 (40)	3	1	7538 (2069)	9		
Emerald shiner	1341 (268)	5	26 (54)	83	12	13 (1)	1	<1	241 (124)	3	5	1048 (344)	4	20	1413 (314)	28	27	38 (10)	2	1	22 (8)	1	<1	379 (171)	18	7	50 (19)	3	1	5187 (921)	6		
White bass	1996 (404)	7	43 (805)	460	15	17 (5)	3	<1	13 (5)	<1	<1	176 (94)	1	4	120 (23)	2	3	958 (198)	55	20	580 (119)	30	12	24 (6)	1	1	9 (3)	1	<1	4687 (1097)	6		
Common carp	1325 (253)	5	28 (343)	165	6	7 (<1 (<1)	<1	<1	273 (83)	4	6	1559 (763)	5	33	833 (174)	16	18	2 (1)	<1	<1	18 (8)	1	<1	228 (44)	11	5	74 (28)	5	2	4655 (1034)	6		
Bluegill	516 (96)	2	15 (372)	172	7	10 (44)	16	42	1	94 (46)	1	3	1481 (642)	5	42	241 (31)	5	7	92 (11)	5	3	18 (3)	1	<1	106 (17)	5	3	582 (273)	36	16	3546 (756)	4	
Freshwater drum	371 (72)	1	17 (90)	59	2	4 (<1 (<1)	<1	<1	22 (6)	<1	1	176 (35)	1	8	1087 (271)	21	51	5 (2)	<1	<1	4 (3)	<1	<1	366 (169)	18	17	12 (5)	1	1	2134 (533)	3		
Black crappie	194 (40)	1	11 (43)	23	1	2 (40)	8	38	2	20 (7)	<1	1	121 (37)	<1	1	22 (7)	<1	1	79 (14)	4	4	1207 (599)	63	69	7 (2)	<1	<1	26 (21)	2	1	1759 (598)	2	
Channel catfish	664 (105)	2	39 (303)	119	5	18 (<1 (<1)	<1	<1	76 (48)	1	4	20 (5)	<1	1	141 (28)	3	8	444 (75)	25	26	30 (9)	2	2	37 (10)	2	2	4 (2)	<1	<1	1720 (168)	2		
Smallmouth buffalo	240 (61)	1	29 (53)	22	1	7 (<1 (<1)	<1	<1	16 (5)	<1	1	119 (31)	<1	15	260 (71)	5	32	5 (3)	<1	<1	5 (3)	<1	<1	103 (42)	5	13	14 (5)	1	2	816 (185)	1		
White crappie	434 (97)	2	62 (84)	33	2	12 (54)	23	12	<1 (<1)	<1	<1	79 (43)	1	11	66 (16)	<1	9	26 (9)	1	4	1 (<1)	<1	<1	6 (3)	<1	1	<1	<1	<1	<1	695 (129)	1	
Largemouth bass	239 (87)	1	39 (18)	6	<1	3 (<1 (<1)	<1	<1	186 (134)	3	30	85 (37)	<1	14	31 (10)	1	5	<1 (<1)	<1	<1	<1	<1	<1	26 (18)	1	4	32 (16)	2	5	618 (236)	1		
Threadfin shad	462 (81)	2	80 (78)	28	1	13 (<1 (<1)	<1	<1	15 (9)	<1	3	5 (3)	<1	9 (3)	<1	2	3 (1)	<1	<1	<1	<1	<1	<1	4 (1)	<1	1	2 (1)	<1	<1	577 (91)	1		
Bigmouth buffalo	289 (174)	1	65 (10)	4	<1	2 (<1 (<1)	<1	<1	62 (45)	1	14	10 (4)	<1	2	37 (21)	1	8	<1 (<1)	<1	<1	<1	<1	<1	3 (2)	<1	1	33 (29)	2	7	445 (207)	1		
Skipjack herring	6 (3)	<1	2 (<1 (<1)	<1	<1	<1	<1	<1	205 (90)	3	55	158 (109)	<1	43	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	369 (124)	<1	
Western mosquitofish	113 (27)	<1	38 (82)	27	1	27 (3	2)	3	1	8 (2)	<1	3	51 (16)	<1	17	29 (7)	1	10	1 (<1)	<1	<1	<1	<1	8 (1)	<1	3	3 (2)	<1	1	299 (52)	<1		
Sauger	28 (3)	<1	11 (14)	2	<1	6 (<1 (<1)	<1	<1	21 (5)	<1	9	7 (2)	<1	3	127 (29)	3	51	2 (1)	<1	<1	<1	<1	<1	24 (6)	1	10	4 (1)	<1	2	252 (45)	<1		
Shorthead gar	68 (16)	<1	29 (15)	3	<1	6 (<1 (<1)	<1	<1	22 (35)	2	56	63 (23)	<1	29	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	23 (6)	1	10	1 (<1)	<1	234 (25)	<1			
River carp sucker	26 (9)	<1	12 (2)	1	<1	1 (<1 (<1)	<1	<1	122 (35)	2	56	63 (23)	<1	29	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	3 (1)	<1	1	217 (37)	<1		
Bullhead minnow	22 (7)	<1	13 (8)	4	<1	5 (<1 (<1)	<1	<1	74 (33)	1	43	67 (23)	<1	39	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	171 (47)	<1		
Red shiner	48 (15)	<1	31 (12)	6	<1	8 (1)	1	1	2 (1)	<1	2	7 (5)	<1	5	61 (14)	1	40	2 (1)	<1	<1	<1	<1	<1	18 (6)	1	12	<1	<1	<1	153 (41)	<1		
Shorthead darters	21 (12)	<1	17 (3)	1	<1	3 (<1 (<1)	<1	<1	38 (20)	1	31	56 (34)	<1	45	3 (1)	<1	2	<1 (<1)	<1	<1	<1	<1	<1	1 (1)	<1	1	1 (1)	<1	1	123 (54)	<1		
Golden shiner	3 (1)	<1	3 (1)	1	<1	1 (<1 (<1)	<1	<1	<1	<1	<1	9 (3)	<1	8	42 (20)	1	36	12 (5)	1	11	16 (9)	1	14	31 (8)	1	26	1 (1)	<1	1	116 (23)	<1		
Brown bullhead	27 (6)	<1	28 (16)	5	<1	17 (<1 (<1)	<1	<1	<1	<1	<1	6 (2)	<1	6	25 (10)	1	27	<1 (<1)	<1	<1	<1	<1	<1	15 (6)	1	16	4 (4)	<1	4	95 (22)	<1		
Yellow bass	11 (5)	<1	12 (1)	1	<1	1 (<1 (<1)	<1	<1	<1	<1	<1	27 (12)	<1	30	28 (9)	1	32	1 (1)	<1	<1	<1	<1	<1	16 (7)	1	18	4 (1)	<1	4	88 (17)	<1		
Yellow bullhead	17 (6)	<1	20 (7)	4	<1	8 (<1 (<1)	<1	<1	37 (9)	1	42	26 (14)	<1	29	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	87 (20)	<1		
Brook silverside	5 (2)	<1	6 (2)	1	<1	2 (<1 (<1)	<1	<1	<1	<1	<1	42 (10)	<1	54	13 (4)	<1	17	1 (1)	<1	2	3 (1)	<1	4	8 (2)	<1	11	3 (2)	<1	4	77 (14)	<1		
Black bullhead	8 (5)	<1	11 (2)	1	<1	3 (<1 (<1)	<1	<1	15 (8)	<1	21	46 (22)	<1	64	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1	1	72 (33)	<1		
Silverband shiner	34 (6)	<1	47 (11)	1	<1	15 (<1 (<1)	<1	<1	<1	<1	<1	7 (3)	<1	1	3 (1)	<1	7	1 (2)	<1	15	6 (2)	<1	8	1 (<1)	<1	1	<1	<1	<1	72 (9)	<1		
Flathead catfish	1 (1)	<1	2 (<1 (<1)	<1	<1	<1	<1	<1	7 (3)	<1	10	60 (54)	<1	88	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	68 (55)	<1		
Bluntnose minnow	12 (6)	<1	25 (2)	1	<1	4 (<1 (<1)	<1	<1	4 (4)	<1	8	28 (26)	<1	59	1 (1)	<1	2	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	47 (30)	<1		
Grass carp	10 (7)	<1	57 (4)	1	<1	20 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	3 (2)	<1	18	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	18 (8)	<1		
Goldeye	3 (1)	<1	23 (4)	1	<1	26 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	2	5 (2)	<1	33	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	15 (2)	<1		
Walleye	<1 (<1)	<1	4 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	21	<1 (<1)	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3 (2)	<1		
Northern pike	<1 (<1)	<1	14 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Blue catfish	<1 (<1)	<1	14 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Bighead carp	<1 (<1)	<1	67 (<1 (<1)	<1	<1	33 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Paddlefish	<1 (<1)	<1	100 (<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1 (<1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		
Silver carp	0 (0)	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0								

Appendix E. Catch by Gear Type for Fish Less Than 120 mm

Appendix E contains six tables, one for each trend analysis area, listing mean annual catch and variance of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program and the percentage of total annual catch accounted for by that species within each gear and across all gears. Only fish <120 mm in total length were included in these analyses. Information on how each gear is fished and what constitutes an independent sample can be found in Gutreuter et al. (1995.)

Table E-1. For Navigation Pool 4, mean annual catch of fish <120 mm in total length and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). *N* is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within Navigation Pool 4 are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

	Day electrofishing N = 81.3 (1.8)			Night electrofishing N = 11.7 (0.2)			Bottom trawling N = 4.0 (0.8)			Sailing N = 30.4 (2.2)			Mini fyke nets N = 61.1 (2.5)			Fyke nets N = 32.3 (1.9)			Large hoop nets N = 55.4 (3.1)			Small hoop nets N = 55.4 (3.3)			Tandem fyke nets N = 26.6 (1.3)			Tandem mini fyke nets N = 26.6 (1.2)			All gears combined N = 384.7 (8.6)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	Percentage of this species in total catch																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
Emerald shiner	4030 (1088)	63	8	4951 (4951)	78	10	1	8713 (2904)	73	17	34116 (18016)	94	66	20 (8)	8	1	173 (85)	27	1	173 (85)	27	1	173 (85)	27	1	173 (85)	27	1	173 (85)	27	1	51984 (18989)	83																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Gizzard shad	637 (96)	10	32	1109 (1109)	18	56	1	92 (47)	1	5	92 (35)	1	5	20 (8)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1841 (383)	3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Sportfish shiner	218 (59)	3	12	6 (6)	1	1	1	1396 (335)	12	76	212 (70)	1	12	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1841 (383)	3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Bluegill	353 (66)	6	27	68 (68)	1	5	1	100 (45)	1	8	488 (131)	1	37	93 (28)	38	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1311 (228)	2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
Mimic shiner	29 (11)	1	3	3 (3)	1	1	1	517 (210)	4	54	388 (122)	1	41	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	949 (226)	2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Bullhead minnow	56 (26)	1	8	3 (3)	1	1	1	404 (137)	3	61	163 (74)	1	25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	661 (193)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
White bass	130 (51)	2	21	88 (88)	1	14	1	101 (45)	1	16	206 (115)	1	33	31 (13)	13	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	619 (272)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Black crappie	34 (14)	1	10	3 (3)	1	1	1	8 (2)	1	2	30 (9)	1	9	74 (11)	31	22	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	339 (65)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
River shiner	99 (32)	2	38	2 (2)	1	1	1	150 (36)	1	57	11 (4)	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	261 (61)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Largemouth bass	151 (26)	2	63	9 (9)	1	4	1	20 (7)	1	8	56 (36)	1	24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	239 (43)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Logperch	95 (32)	1	44	13 (13)	1	6	1	41 (9)	1	19	49 (20)	1	23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	214 (52)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Spottail shiner	58 (17)	1	31	1 (1)	1	1	1	56 (24)	1	30	33 (13)	1	17	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	169 (43)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Yellow perch	119 (37)	2	75	1 (1)	1	1	1	19 (10)	1	12	11 (5)	1	7	4 (4)	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	169 (43)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Johnny darter	10 (1)	1	7	1 (1)	1	1	1	85 (15)	1	58	23 (11)	1	16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	147 (39)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Smallmouth bass	28 (9)	1	25	13 (13)	1	9	1	20 (5)	1	13	2 (1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	147 (27)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Freshwater drum	118 (21)	1	21	5 (5)	1	4	1	9 (3)	1	7	12 (6)	1	9	6 (2)	3	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	134 (23)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Pugnose minnow	12 (3)	1	12	1 (1)	1	1	1	3 (3)	1	3	51 (14)	1	50	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	101 (25)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Common carp	27 (24)	1	28	1 (1)	1	1	1	3 (2)	1	3	46 (29)	1	47	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	97 (56)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Speckled chub	1 (1)	1	1	1 (1)	1	1	1	34 (32)	1	37	51 (18)	1	56	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	91 (28)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Rock bass	36 (7)	1	40	1 (1)	1	1	1	10 (3)	1	11	7 (3)	1	8	9 (3)	4	10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	82 (36)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Quillback	10 (5)	1	12	1 (1)	1	1	1	68 (31)	1	84	2 (1)	1	2	1 (1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	62 (30)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Sauger	25 (10)	1	40	37 (37)	1	60	1	6 (3)	1	10	2 (2)	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	36 (30)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
White crappie	3 (1)	1	9	2 (2)	1	6	1	1 (1)	1	1	7 (2)	1	19	1 (1)	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25 (9)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Walleye	13 (7)	1	53	10 (10)	1	39	1	3 (1)	1	13	1 (1)	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	24 (24)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Smallmouth buffalo	1 (1)	1	4	1 (1)	1	1	1	1 (1)	1	1	1 (1)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15 (4)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Channel catfish	1 (1)	1	1	1 (1)	1	1	1	1 (1)	1	1	1 (1)	1	1	9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15 (4)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Northern pike	2 (1)	1	14	1 (1)	1	1	1	6 (4)	1	42	4 (1)	1	26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4 (2)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Bignown buffalo	1 (1)	1	31	1 (1)	1	1	1	1 (1)	1	23	1 (1)	1	38	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3 (2)	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
Flathead catfish	1 (1)	1	45	1 (1)	1	1	1	1 (1)	1	20	1 (1)	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table E-4. For Navigation Pool 26, mean annual catch of fish <120 mm in total length and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within Navigation Pool 26 are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

Species	Day electrofishing N = 70 (7.3)			Night electrofishing N = 6.0 (6.0)			Bottom trawling N = 3.0 (3.0)			Seining N = 35.1 (3.7)			Mini fyke nets N = 40.3 (4.5)			Fyke nets N = 22.0 (1.7)			Large hoop nets N = 50.5 (4.7)			Small hoop nets N = 50.0 (4.8)			Tandem fyke nets N = 11.0 (1.0)			Tandem mini fyke nets N = 11.0 (1.0)			All gears combined N = 298.0 (30.9)							
	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	This All gear	Percentage annual catch	Mean annual catch (variance)	Percentage annual catch	Mean annual catch (variance)	Percentage annual catch							
Gizzard shad	2526 (672)	57	38	108 (23)	63	2	<1	<1	<1	1354 (379)	32	20	2268 (1102)	36	34	17	7	8	<1	<1	<1	<1	<1	<1	60 (18)	28	1	413 (171)	39	6	6716 (1601)	40						
Emerald shiner	373 (80)	8	16	12 (3)	7	1	<1	<1	<1	1173 (332)	28	51	650 (272)	10	28	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	105 (43)	10	5	2312 (592)	14						
Channel shiner	25 (11)	1	2	5 (2)	3	<1	<1	<1	<1	429 (195)	10	32	889 (738)	14	66	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	6 (3)	1	<1	1353 (921)	8						
Freshwater drum	152 (24)	3	17	15 (2)	8	2	54 (35)	74	6	92 (64)	2	10	410 (157)	6	45	8 (6)	4	1	<1	<1	<1	<1	<1	<1	<1	<1	29 (23)	14	3	187 (44)	18	20	919 (165)	5				
River shiner	37 (9)	1	4	4 (2)	2	<1	<1	<1	<1	667 (337)	16	74	190 (155)	3	21	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	896 (477)	5						
Western mosquitofish	43 (27)	1	5	1 (1)	<1	<1	<1	<1	<1	26 (12)	1	3	808 (483)	13	92	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1	<1	879 (491)	5						
White bass	143 (37)	3	25	42 (15)	24	7	<1	<1	<1	83 (21)	2	14	223 (111)	4	39	28 (5)	13	5	<1	<1	<1	<1	<1	<1	<1	<1	15 (4)	7	3	68 (22)	6	12	578 (189)	3				
Bluegill	294 (47)	7	52	12 (4)	7	2	<1	<1	<1	7 (2)	<1	1	116 (39)	2	20	88 (33)	43	16	<1	<1	<1	<1	<1	<1	<1	<1	4	1	1	18 (8)	9	3	36 (13)	3	6	568 (98)	3	
Spottfin shiner	38 (11)	1	9	2 (1)	1	<1	<1	<1	<1	143 (58)	3	32	260 (131)	4	59	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	443 (181)	3					
Orangespotted sunfish	267 (71)	6	66	1 (<1)	<1	<1	<1	<1	<1	2 (2)	<1	<1	58 (14)	1	14	3 (1)	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1	1	62 (44)	7	18	402 (101)	2			
Channel catfish	78 (24)	2	25	3 (2)	2	1	17 (6)	23	5	48 (16)	1	15	74 (45)	1	24	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	30 (27)	87	10	3 (3)	1	62 (44)	6	20	312 (126)	2	
Bullhead minnow	70 (19)	2	34	1 (<1)	<1	<1	<1	<1	<1	22 (5)	1	11	90 (24)	1	43	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	26 (13)	2	13	209 (46)	1			
Black crappie	11 (5)	<1	6	<1	<1	<1	<1	<1	<1	1 (1)	<1	1	36 (8)	1	19	53 (47)	26	28	<1	<1	<1	<1	<1	<1	<1	<1	<1	6	1	78 (65)	37	41	9 (5)	1	5	190 (125)	1	
Smallmouth buffalo	74 (18)	2	66	<1	<1	<1	<1	<1	<1	4 (1)	<1	<1	23 (13)	<1	20	4 (3)	2	3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	8 (4)	1	7	113 (32)	1			
River carp sucker	44 (10)	1	42	1 (1)	1	<1	<1	<1	<1	53 (17)	1	50	5 (4)	<1	5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3 (2)	<1	2	104 (28)	1			
Silverband shiner	6 (2)	<1	8	<1	<1	<1	<1	<1	<1	9 (5)	<1	12	44 (23)	1	61	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	14 (4)	1	19	73 (22)	<1			
Common carp	29 (11)	1	42	<1	<1	<1	<1	<1	<1	7 (5)	<1	10	19 (8)	<1	28	4 (4)	2	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	15 (4)	1	14	70 (22)	<1			
Skipjack herring	42 (15)	1	64	<1	<1	<1	<1	<1	<1	23 (12)	1	34	1 (<1)	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	66 (21)	<1				
Red shiner	4 (2)	<1	6	<1	<1	<1	<1	<1	<1	23 (10)	1	37	35 (19)	1	57	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	62 (24)	<1				
Bighorn buffalo	39 (36)	1	71	<1	<1	<1	<1	<1	<1	<1	<1	<1	16 (15)	<1	29	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	55 (51)	<1					
Silver chub	13 (4)	<1	28	1 (<1)	<1	<1	<1	<1	<1	16 (4)	<1	33	8 (4)	<1	16	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10 (4)	1	22	48 (12)	<1			
Miss. silvery minnow	3 (2)	<1	8	<1	<1	<1	<1	<1	<1	6 (3)	<1	18	23 (14)	<1	74	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	31 (18)	<1	31	31 (4)	<1			
White crappie	4 (1)	<1	12	<1	<1	<1	<1	<1	<1	1 (1)	<1	4	11 (3)	<1	36	2 (1)	1	8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	4 (2)	2	14	9 (3)	1	28	31 (4)	<1
Brook silverside	5 (2)	<1	17	<1	<1	<1	<1	<1	<1	20 (11)	<1	69	4 (2)	<1	12	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	29 (14)	<1			
Largemouth bass	16 (6)	<1	60	<1	<1	<1	<1	<1	<1	2 (1)	<1	7	9 (3)	<1	33	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	27 (8)	<1				
Mooneye	7 (6)	<1	27	<1	<1	<1	<1	<1	<1	16 (9)	<1	66	1 (1)	<1	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3 (3)	<1				
Sauger	13 (3)	<1	56	2 (2)	1	8	<1	<1	<1	1 (1)	<1	5	6 (2)	<1	25	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1	10	24 (5)	<1			
Goldeye	17 (16)	<1	70	<1	<1	<1	<1	<1	<1	7 (6)	<1	28	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	24 (23)	<1				
Shortnose gar	2 (1)	<1	9	<1	<1	<1	<1	<1	<1	<1	<1	<1	21 (8)	<1	89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	24 (9)	<1				
Flathead catfish	3 (1)	<1	69	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	12	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	4 (1)	<1					
Grass carp	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	8	3 (3)	<1	88	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3 (3)	<1					
Bighorn carp	<1	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1	58	1 (<1)	<1	33	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1					
Blue catfish	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1	91	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1					
Walleye	1 (1)	<1	45	<1	<1	<1	<1	<1	<1	<1	<1	9	1 (<1)	<1	45	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1					
Blue sucker	<1	<1	50	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	50	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1					
Lake sturgeon	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0 (0)	0	0							

Table E-5. For Open River, mean annual catch of fish <120 mm in total length and variance (*in parentheses*) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (*in parentheses*). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 98% of the total catch within Open River are included, except that species of particular management interest that did not contribute to the top 98% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

Species	Day electrofishing N = 43.7 (5.1)			Night electrofishing N = 0			Bottom trawling N = 19.5 (9.1)			Seining N = 6.8 (1.2)			Mini fyke nets N = 60.1 (4.8)			Fyke nets N = 19.9 (1.2)			Large hoop nets N = 51.1 (6.1)			Small hoop nets N = 52.1 (6.3)			Tandem fyke nets N = 0			Tandem mini fyke nets N = 0			All gears combined N = 247.0 (27.9)		
	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Mean annual catch (variance)	This All gear years	Annual This All gear years	Percentage of species in total annual catch		
Freshwater drum	65 (18)	2	1	87 (40)	48	2	8 (4)	1	4263 (1431)	57	97	1 (1)	185 (178)	13	4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	32	
Gizzard shad	3067 (894)	73	70	1 (1)	<1	<1	281 (89)	48	6	897 (406)	12	20	1003 (980)	70	93	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	4389 (1221)	
Black crappie	5 (2)	<1	<1	<1	<1	<1	<1	<1	61 (27)	1	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	8	
Channel shiner	35 (18)	1	5	20 (19)	11	3	22 (15)	4	3	627 (325)	8	90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1075 (1004)	
Emerald shiner	177 (62)	4	30	<1	<1	<1	132 (72)	22	22	297 (133)	4	51	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	697 (352)	
Bluegill	83 (13)	2	21	<1	<1	<1	<1	<1	<1	301 (126)	4	76	9 (5)	179 (174)	13	52	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	586 (226)	
White bass	50 (12)	1	15	<1	<1	<1	10 (4)	2	3	106 (36)	1	31	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	394 (138)	
Red shiner	173 (66)	4	50	<1	<1	<1	26 (14)	4	7	148 (69)	2	43	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	344 (156)	
Channel catfish	46 (14)	1	18	50 (26)	28	20	18 (5)	3	7	143 (39)	2	57	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	343 (104)	
Goldeye	216 (114)	5	88	<1	<1	<1	4 (3)	1	2	26 (12)	<1	11	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	252 (50)	
White crappie	22 (13)	1	16	<1	<1	<1	<1	<1	<1	81 (32)	1	57	37 (31)	3	26	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	247 (128)
Silverhand shiner	16 (5)	<1	13	1 (1)	1	1	6 (2)	1	5	102 (37)	1	83	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	143 (50)
River carpsucker	12 (4)	<1	17	<1	<1	<1	16 (10)	3	21	48 (43)	1	65	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	123 (43)
Common carp	4 (2)	<1	5	<1	<1	<1	<1	<1	<1	69 (33)	1	94	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	74 (55)
River shiner	17 (11)	<1	25	<1	<1	<1	37 (17)	6	54	19 (8)	<1	28	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	73 (34)
Orangespotted sunfish	26 (13)	1	49	<1	<1	<1	<1	<1	<1	26 (10)	<1	47	2 (2)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	73 (34)
Miss. silvery minnow	5 (3)	<1	11	<1	<1	<1	13 (6)	2	28	31 (25)	<1	66	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	67 (19)
Brook silverside	30 (17)	1	90	<1	<1	<1	<1	<1	<1	3 (1)	<1	8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	54 (22)
Spotted bass	31 (13)	1	91	<1	<1	<1	<1	<1	<1	3 (1)	<1	9	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	47 (29)
Green sunfish	19 (12)	<1	59	<1	<1	<1	<1	<1	<1	7 (2)	<1	23	6 (6)	<1	18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	34 (17)
Threadfin shad	17 (9)	<1	57	<1	<1	<1	<1	<1	<1	12 (10)	<1	40	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	34 (14)
Western mosquitofish	12 (8)	<1	42	<1	<1	<1	<1	<1	<1	16 (4)	<1	57	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	32 (19)
Silver chub	6 (2)	<1	28	<1	<1	<1	2 (1)	<1	9	15 (4)	<1	64	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	29 (19)
Bigmouth buffalo	<1	<1	<1	<1	<1	<1	<1	<1	<1	19 (18)	<1	100	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	28 (11)
Skipjack herring	7 (4)	<1	45	<1	<1	<1	4 (2)	1	23	5 (2)	<1	34	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	23 (5)
Bullhead minnow	2 (1)	<1	16	<1	<1	<1	<1	<1	<1	13 (5)	<1	84	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	19 (18)
Warmouth	6 (4)	<1	41	<1	<1	<1	<1	<1	<1	9 (3)	<1	59	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	16 (6)
Sauger	4 (2)	<1	29	<1	<1	<1	2 (1)	<1	11	9 (3)	<1	60	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	15 (5)
Blue catfish	<1	<1	<1	10 (4)	6	83	1 (1)	<1	7	3 (1)	<1	23	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	15 (4)
Speckled chub	1	<1	6	6 (4)	3	47	1 (1)	<1	8	6 (2)	<1	46	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	12 (4)
Blacktail shiner	4 (3)	<1	41	<1	<1	<1	<1	<1	<1	6 (3)	<1	59	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	12 (5)
Smallmouth buffalo	2 (2)	<1	21	<1	<1	<1	1 (1)	<1	5	1 (1)	<1	8	7 (7)	<1	76	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10 (4)
Bighead carp	1 (1)	<1	6	<1	<1	<1	<1	<1	<1	8 (4)	<1	87	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	9 (6)
Flathead catfish	5 (2)	<1	71	<1	<1	<1	<1	<1	<1	2 (1)	<1	29	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	9 (5)
Largemouth bass	6 (5)	<1	94	<1	<1	<1	<1	<1	<1	<1	<1	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	7 (2)
Blue sucker	<1	<1	9	<1	<1	<1	<1	<1	<1	3 (2)	<1	86	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	7 (5)
Shovelnose sturgeon	<1	<1	<1	3 (2)	2	83	<1	<1	<1	1	<1	17	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3 (2)
Paddlefish	<1	<1	<1	1 (1)	<1	85	<1	<1	<1	<1	<1	15	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	&		

Table E-6. For La Grange Pool, mean annual catch of fish <120 mm in total length and variance (in parentheses) of catch for fish species collected in each gear used by the Long Term Resource Monitoring Program (LTRMP) and the percentage of total annual catch accounted for by that species within a gear (a column) and across all gears (a row). "N" is the mean number of independent samples collected annually with one standard error (in parentheses). Species are listed in order of abundance in total annual catch for all gears combined. Only species comprising the top 99% of the total catch within La Grange Pool are included, except that species of particular management interest that did not contribute to the top 99% are also included. Data were from stratified random sampling during 1993 through 1999 in the LTRMP Fish Component. (Shaded bars are added for readability.)

Species	Day electrofishing N = 107.7 (10.9)			Night electrofishing N = 27.3 (7.6)			Bottom trawling N = 11.4 (0.4)			Sailing N = 44.3 (2.5)			Mini fyke nets N = 82.7 (4.7)			Fyke nets N = 36.6 (3.4)			Large hoop nets N = 61.6 (2.2)			Small hoop nets N = 92.3 (2.9)			Tandem fyke nets N = 14.6 (1.2)			Tandem mini fyke nets N = 14.6 (1.2)			All gears combined N = 463.0 (19.4)			
	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Mean annual catch (variance)	This gear	All gears	Percentage of this species in total annual catch			
Gizzard shad	15474 (5884)	79	38	1654 (523)	62	4	7 (7)	11	<1	4211 (1734)	60	10	18064 (8238)	62	45	162 (51)	9	<1	<1	<1	<1	<1	<1	<1	267 (80)	45	1	667 (306)	43	2	40506 (14589)	65		
Emerald shiner	696 (194)	4	9	91 (29)	3	1	<1	<1	<1	1042 (230)	15	14	5654 (1759)	19	75	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	55 (40)	4	1	7538 (2069)	12				
Bluegill	1042 (183)	5	27	250 (113)	9	6	<1	<1	<1	271 (83)	4	7	1533 (763)	5	40	597 (116)	34	15	<1	<1	<1	<1	<1	<1	<1	95 (34)	16	2	72 (23)	5	2	3870 (917)	6	
White bass	815 (177)	4	27	314 (50)	12	11	<1	<1	<1	236 (124)	3	8	912 (287)	3	31	613 (240)	35	20	<1	<1	<1	<1	<1	<1	<1	51 (18)	9	2	47 (20)	3	2	2989 (623)	5	
Freshwater drum	299 (69)	2	11	150 (69)	6	6	23 (8)	36	1	91 (46)	1	3	1443 (645)	5	55	38 (15)	2	1	<1	<1	<1	<1	<1	<1	<1	25 (10)	4	1	570 (273)	37	22	2642 (783)	4	
Theadfin shad	228 (85)	1	39	17 (6)	1	3	<1	<1	<1	186 (134)	3	32	74 (37)	<1	13	23 (7)	1	4	<1	<1	<1	<1	<1	<1	<1	25 (18)	4	4	31 (16)	2	5	586 (233)	1	
Black crappie	49 (17)	<1	9	20 (19)	1	4	<1	<1	<1	15 (6)	<1	3	121 (41)	<1	22	254 (106)	15	46	<1	<1	<1	<1	<1	<1	<1	104 (72)	18	19	7 (4)	1	1	357 (182)	1	
Striped bass	270 (173)	1	71	<1	<1	<1	<1	<1	<1	61 (45)	1	16	8 (3)	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	379 (198)	1	
Common carp	115 (64)	1	30	221 (193)	8	59	<1	<1	<1	11 (4)	<1	3	149 (92)	1	40	1 (1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	378 (129)	1	
Western mosquitofish	6 (3)	<1	2	<1	<1	<1	<1	<1	<1	205 (90)	3	55	158 (109)	1	43	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	369 (124)	1
Largemouth bass	151 (45)	1	50	19 (9)	1	6	<1	<1	<1	73 (43)	1	24	60 (15)	<1	20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	304 (65)	<1
Channel catfish	35 (10)	<1	14	9 (6)	<1	4	32 (8)	51	13	19 (8)	<1	8	114 (38)	<1	47	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	242 (56)	<1
Bullhead minnow	26 (9)	<1	12	2 (1)	<1	1	<1	<1	<1	122 (35)	2	56	63 (23)	<1	29	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	217 (37)	<1
White crappie	31 (18)	<1	15	3 (3)	<1	1	<1	<1	<1	15 (4)	<1	7	87 (32)	<1	41	6 (4)	2	19	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	210 (47)	<1
Smallmouth buffalo	94 (39)	<1	47	13 (5)	<1	6	<1	<1	<1	70 (48)	1	35	13 (6)	<1	6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	200 (54)	<1
Red shiner	22 (7)	<1	13	8 (4)	<1	5	<1	<1	<1	74 (33)	1	43	67 (23)	<1	39	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	171 (47)	<1
Golden shiner	19 (12)	<1	17	3 (1)	<1	2	<1	<1	<1	38 (20)	1	33	55 (34)	<1	47	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	117 (55)	<1
Brook silverside	17 (6)	<1	20	7 (4)	<1	8	<1	<1	<1	37 (9)	1	42	26 (14)	<1	29	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	87 (20)	<1
Silverband shiner	8 (5)	<1	11	2 (1)	<1	3	<1	<1	<1	15 (8)	<1	21	46 (22)	<1	64	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	72 (33)	<1
Bluntnose minnow	1 (1)	<1	2	<1	<1	<1	<1	<1	<1	7 (3)	<1	10	60 (54)	<1	88	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	68 (55)	<1
Logperch	12 (3)	<1	22	1 (<1)	<1	1	<1	<1	<1	4 (2)	<1	7	39 (12)	<1	70	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	55 (13)	<1
Silver chub	10 (3)	<1	19	1 (1)	<1	2	<1	<1	<1	32 (14)	<1	59	10 (2)	<1	18	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	55 (14)	<1
Orangespotted sunfish	19 (6)	<1	38	1 (1)	<1	3	<1	<1	<1	6 (2)	<1	13	20 (5)	<1	40	2 (1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	50 (13)	<1
Sauger	17 (5)	<1	35	3 (2)	<1	7	<1	<1	<1	1 (<1)	<1	8	22 (6)	<1	46	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	48 (13)	<1
Bignmouth buffalo	14 (10)	<1	37	2 (1)	<1	4	<1	<1	<1	15 (9)	<1	40	5 (3)	<1	14	1 (1)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	37 (16)	<1
Grass carp	1 (1)	<1	2	<1	<1	<1	<1	<1	<1	4 (4)	<1	12	28 (26)	<1	86	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	32 (31)	<1
Flathead catfish	<1 (<1)	<1	8	<1	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1	62	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2 (1)	<1
Walleye	<1 (<1)	<1	60	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1
Goldeye	1 (1)	<1	89	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1 (1)	<1
Bighead carp	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue catfish	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue sucker	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake sturgeon	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern pike	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paddlefish	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shovelnose sturgeon	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silver carp	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0 (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All species	19580 (6248)	100	31	2685 (489)	100	4	63 (14)	100	<1	6962 (1903)	100	11	29049 (9695)	100	47	1741 (223)	100	3	<1	<1	<1	<1	<1	<1	<1	589 (103)	100	1	1548 (433)	100	2	62238 (16672)	100	

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13. ABSTRACT (Maximum 200 words) Evaluations of Long Term Resource Monitoring Program sampling designs for water quality, fish, aquatic vegetation, and macroinvertebrates were initiated in 1999 by analyzing data collected since 1992 in six trend analysis areas. Initial emphasis was placed on evaluating statistical power to detect change from one year or sampling interval to the next, and on determining what spatial, methodological, or target variable redundancies existed in the data sets. Power to detect change was evaluated at halved, present, and doubled levels of effort. Power to detect change for different variables varied widely and was greatly influenced by sample size and for species by their frequency of occurrence. Power for detecting annual and seasonal changes in most water-quality variables seems adequate. A doubling of effort would provide little increase in power, and some reduction or redistribution of effort may be possible. For fish, we could detect a 20% change (at $\alpha = 0.05$ and power of 0.7) in mean annual catch-per-unit-effort for 41 species in at least one trend analysis area. Doubling effort would not appreciably enhance power for rare species. Power for detecting change in aquatic vegetation seemed adequate. However, power for detecting change in macroinvertebrates was low, especially in Navigation Pool 26, the Open River, and La Grange Pool. Results of these analyses should provide useful information for evaluating the effects of potential changes to sampling designs.				
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